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Geology, Energy, and Mineral (GEM)
Resource Assessment of the Eighteen Mile GR
Idaho, including the Eighteen Mile (43-3)
Wilderness Study Area

Bureau of Land Management
Contract No. YA-553-CT2-1039

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PHASE I

Geology, Energy, and Mineral (GEM) Resource Assessment of the Eighteen Mile GRA, Idaho, including the Eighteen Mile (43-3) Wilderness Study Area

Bureau of Land Management
Contract No. YA-553-CT2-1039

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ANCHORAGE, ALASKA
OCTOBER 1983

WGM INC.
MINING AND GEOLOGICAL CONSULTANTS

EXECUTIVE SUMMARY

The Eighteen Mile GRA covers a portion of the Southern Beaverhead Mountains just east of Leadore and along the Idaho-Montana border. The GRA includes one Wilderness Study Area: Eighteen Mile (43-3) totalling 24,922 acres.

Detailed geologic mapping is available for most of the Eighteen Mile GRA, however both the structure and stratigraphy of the area is very complex and not yet fully understood. Bedrock in the area is composed of a thick sequence of quartzites, sandstones and carbonate. These have been intruded by a large granitic pluton and are partly overlain by recent volcanic rocks and sediments. The older rocks have all been thrust-faulted and folded into complex structures.

Deposits of silver-lead-zinc were mined in the Eighteen Mile GRA in the 1880s and a small gypsum mine operated recently. There are also thorium and phosphate prospects in the area. Portions of the Eighteen Mile WSA have moderate potential for metallic minerals, uranium, and thorium; high potential for gypsum deposits. Moderate potential for low temperature geothermal resources is present near the mouth of Eighteenmile Creek. The entire WSA has moderate potential for oil and gas. The land classification for the Eighteen Mile WSA is summarized in the attached table.

SUMMARY OF GEM RESOURCES

LAND CLASSIFICATION FOR THE EIGHTEEN MILE WSA (43-3)

Resource	Classification
1. Locatable Resources	
a. Metallic Minerals	3C/2C
b. Uranium and Thorium	3B/3C
c. Non-Metallic Minerals	4C (gypsum)/ 2C (other)
2. Leasable Resources	
a. Oil and Gas	3C
b. Low Temperature Geothermal	3B/1B
High Temperature Geothermal	1B
c. Sodium and Potassium	2C
d. Other	2C
3. Saleable Resources	4C (limestone)/ 2B (other)

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EIGHTEEN MILE GRA, IDAHO AND MONTANA

1.0 INTRODUCTION

The Bureau of Land Management has adopted a two-phase procedure for the integration of geological, energy and minerals (GEM) resources data into the suitable/non-suitable decision making process for Wilderness Study Area (WSAs). The objective of Phase I is the evaluation of existing data, both published and available unpublished data, for interpretation of the GEM resources potential of the WSAs. Wilderness Study Areas (WSAs) are grouped into areas based on geologic environment and mineral resources for the initial evaluation. These areas are referred to as Geology, Energy, Mineral Resource Areas (GRAs).

The delination of the GRAs is based on three criteria: (1) a 1:250,000 scale map of each GRA shall be no greater than 8½ x 11 inches: (2) a GRA boundary will not cut across a wilderness study area; and (3) the geologic environment and mineral occurrences. The data for each GRA is collected, compiled, and evaluated and a report prepared for each GRA. Each WSA in the GRA is then classified according to GEM resources favorability. The classification system and report format are specified by the BLM to maintain continuity between regions.

This report is prepared for the Bureau of Land Management under contract number YA-553-CT2-1039. The contract covers GEM Region 2; Northern Rocky Mountains (Fig. 1). The Region includes 50 BLM wilderness study areas

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA, Idaho-Montana Location Map

SCALE 1" = 45 MILES
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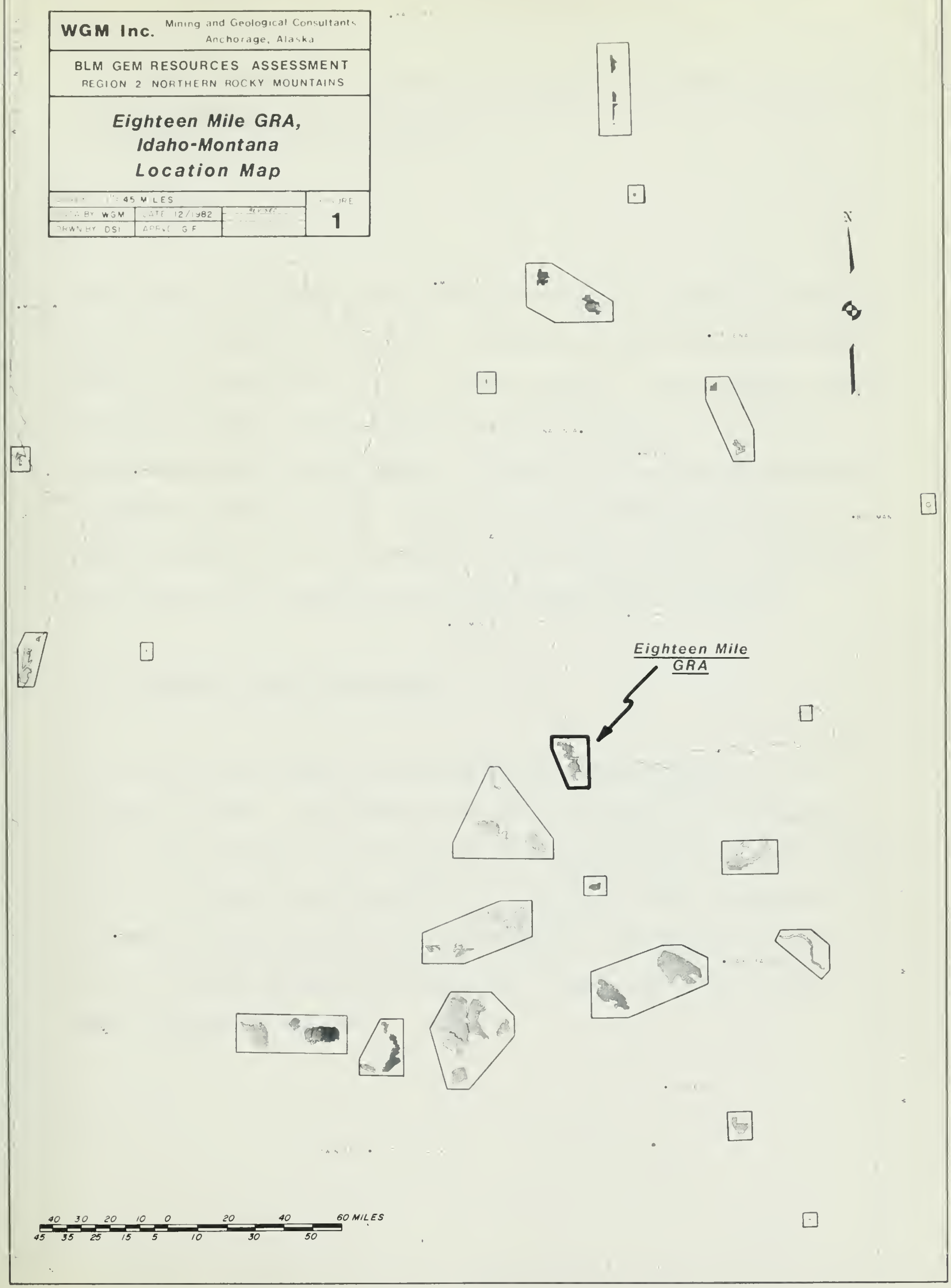
FIGURE 1



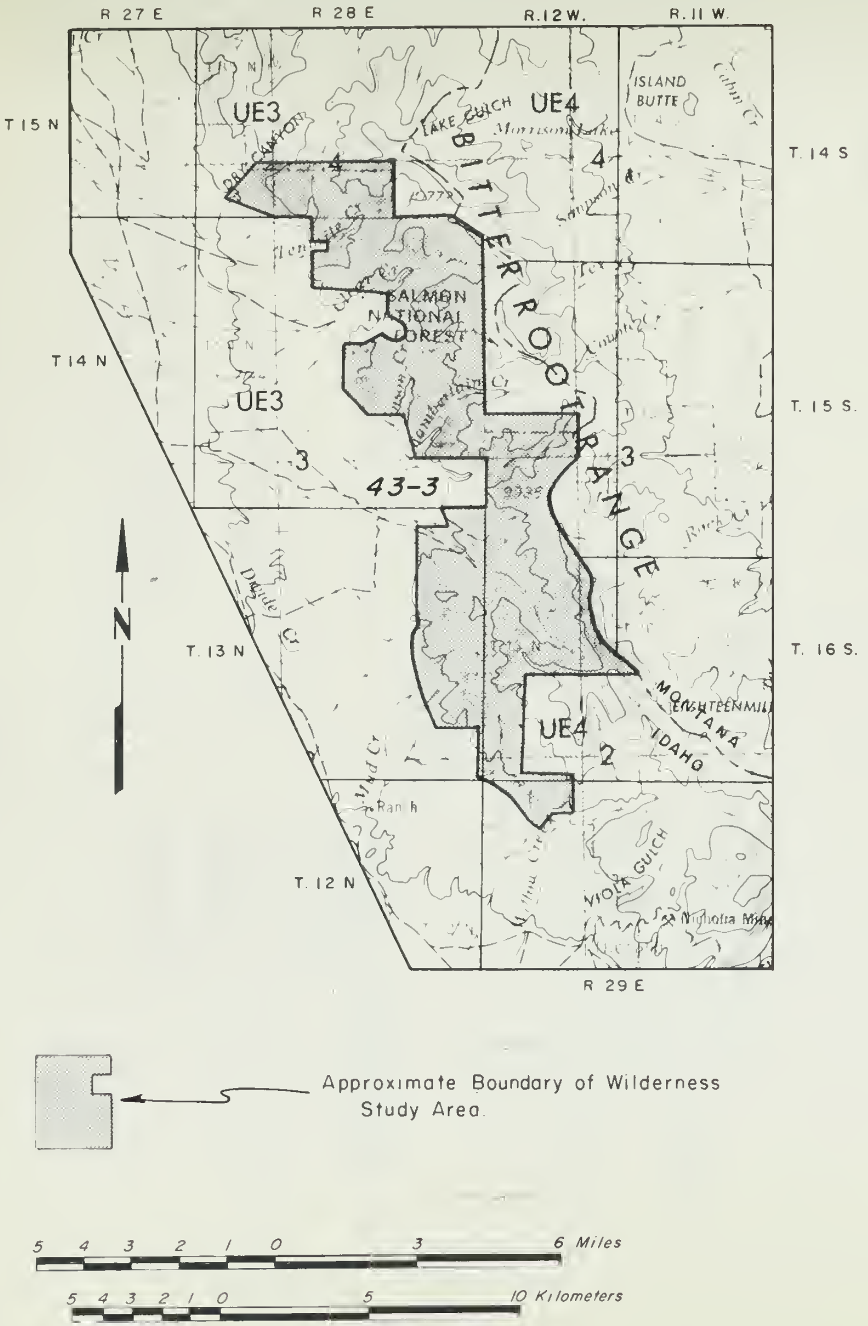
totalling 583,182 acres. The WSAs were grouped into 22 GRAs for purposes of the Phase I GEM resources evaluation.

1.1 Location

The Eighteen Mile Geology, Energy Mineral Resources Area (GRA), encompassing part of the Beaverhead Mountains, is located in Lemhi County, east-central Idaho, and in Beaverhead County, southwest Montana. The Continental Divide follows the crest of the Beaverhead Mountains and marks the political boundary between Idaho and Montana. The GRA is in the Lemhi Resource area of the Salmon BLM district. The GRA includes one Wilderness Study Area (WSA), Eighteen Mile (43-3), totalling 24,922 acres (Fig. 2). The Wilderness Study area is completely within the Idaho portion of the GRA.

1.2 Population and Infrastructure

The nearest town, Leadore, is located about 7 miles northwest of the Eighteen Mile GRA. The nearest paved road, Idaho Route 28, follows the Lemhi and Birch River valleys west of the Beaverhead Mountains and connects with U.S. Highway 20 to the south or U.S. 93 to the north. A number of graded dirt road extend eastward from Highway 28 into numerous canyons on the west side of the Beaverhead Mountains. These provide the principal means of access to the GRA.



BLM Wilderness Study Areas Included in the Eighteen Mile GRA.

WSA	NAME	ACREAGE
43-3	Eighteen Mile	24,922

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA,
Idaho-Montana
Topographic Map

SCALE 1"=4 MILES (1:250,000)			FIGURE
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1.3 Basis of Report

This report is based on a review of the available published and unpublished data on the geology, energy, and mineral resources of the Eighteen Mile GRA. The principal sources of data on the area are publications by the Idaho and Montana Bureau of Mines, the U.S. Geological Survey, the Geological Society of America, university theses, and the Department of Energy. The area has been the subject of continuing geologic study by Robert Scholten of Penn State University and E.T. Ruppel of the U.S. Geological Survey. Consequently, detailed geologic maps of the area are available. Mineral and energy resource information is less abundant.

The data was compiled and reviewed by WGM project personnel and the Ppanel of Experts to produce the resource evaluation which comprises this report. Personnel involved in the report preparation are listed below.

Greg Fernette, Senior Geologist, WGM Inc.	Project Manager
C.G. Bigelow, President, WGM Inc.	Chairman, Panel of Experts
Joel Stratman, Geologist, WGM Inc.	Project Geologist
Jami Fernette, Land and Environmental Coordinator, WGM Inc.	Claims and Lease Compilation

Panel of Experts

C.G. Bigelow, President, WGM Inc.	Regional geology, metallic and minerals, mineral economics.
R.S. Fredericksen, Senior Geologist, WGM Inc.	Regional geology, metallic minerals.
David Blackwell, Ph.D., Professor Geophysics, Southern Methodist University	Geothermal.

Jason Bressler, Senior Geologist, WGM Inc.	Regional geology, metallic minerals.
Gary Webster, Ph.D., Chairman, Department of Geology, Washington State University	Oil and gas.
William Jones, Senior Geologist, WGM Inc.	Metallic minerals, coal, industrial minerals.
J.F. McOuat, President, Watts, Griffis & McOuat Ltd.	Mineral economics, and industrial minerals.
E.F. Evoy, Senior Geologist, Watts, Griffis & McOuat Ltd.	Uranium and thorium.

1.4 Acknowledgements

We would like to thank George Babits, district geologist at the Salmon BLM office for assistance in the compilation phase of this project.

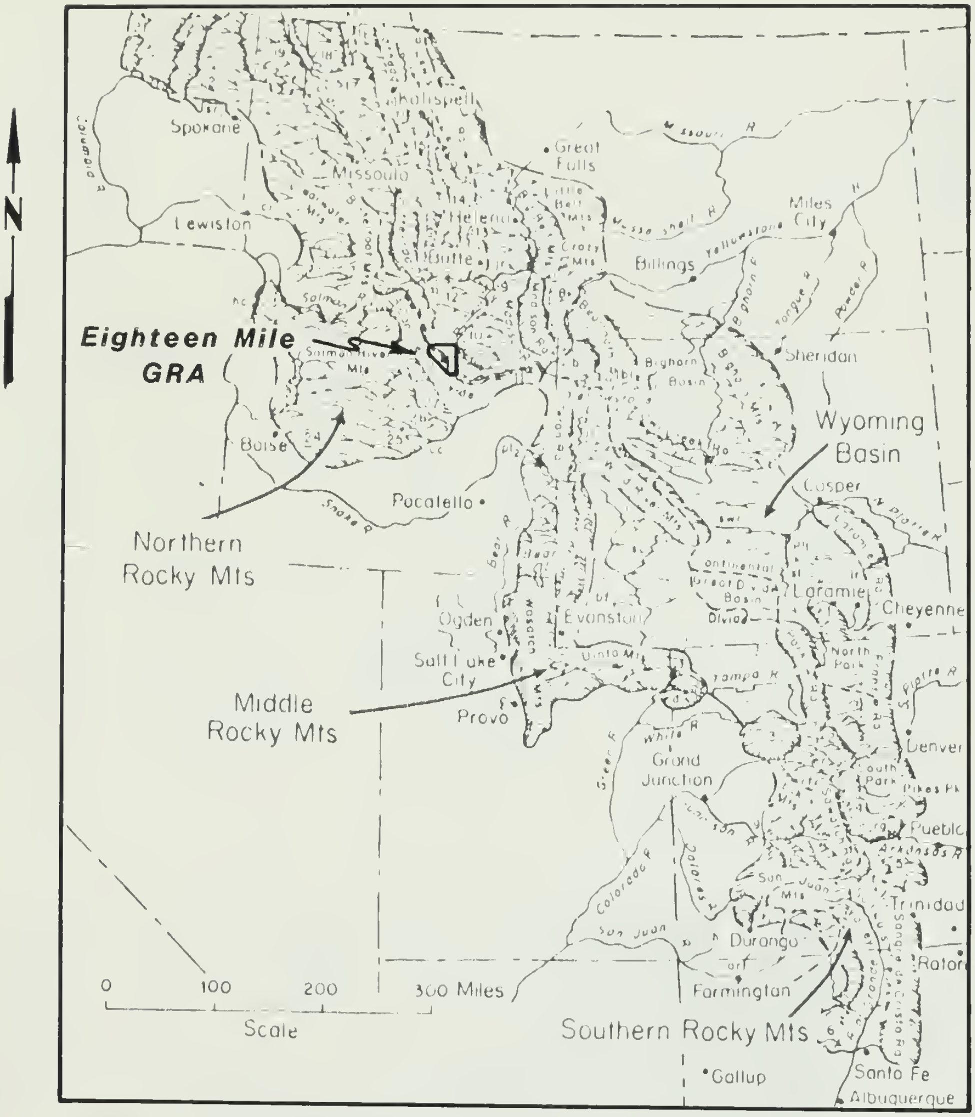
2.0 GEOLOGY

2.1 Introduction

The Eighteen Mile GRA is underlain by a complexly deformed sequence of Precambrian (older than 600 m.y.) through Tertiary (65-2 m.y.) sedimentary and volcanic rocks. These have been intruded by lower Paleozoic (600-230 m.y.) plutons. The geology of the area has been studied by several workers. Early work in the region was of a reconnaissance nature (Kirkham, 1927) or related to the study of mineral deposits (Umpleby, 1913, 1917; Shenon, 1928; Anderson and Wagner, 1944). Recent work by the U.S. Geological Survey includes studies of the thorium deposits just north of the GRA (Staatz et al., 1972), regional structural studies (Ruppel, 1964, 1978, 1982; Ruppel et al., 1981), and detailed geologic mapping in the Leadore Quadrangle (Ruppel, 1968). Detailed work specific to the GRA has also been conducted by Robert Scholten and his students from Penn State University. This work includes studies of intrusive rocks (Ramspott and Scholten, 1964), and structural and stratigraphic studies (Huh, 1967; Lucchitta, 1966; Scholten, 1957, 1967, 1968: Scholten et al., 1955). A summary of this work (Scholten and Ramspott, 1968), presents a detailed geologic map covering most of the GRA and all of WSA 43-3. The geologic mapping was compiled at 1:250,000 scale by Rember and Bennett (1979) which is the basis for Figure 4.

2.2 Physiography

The Eighteen Mile GRA is located in the Northern Rocky Mountains physiographic province (Fig. 3, Hunt, 1974). Topography in east-central Idaho is



Data from: Hunt (1974).

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA, Idaho

Physiographic Setting

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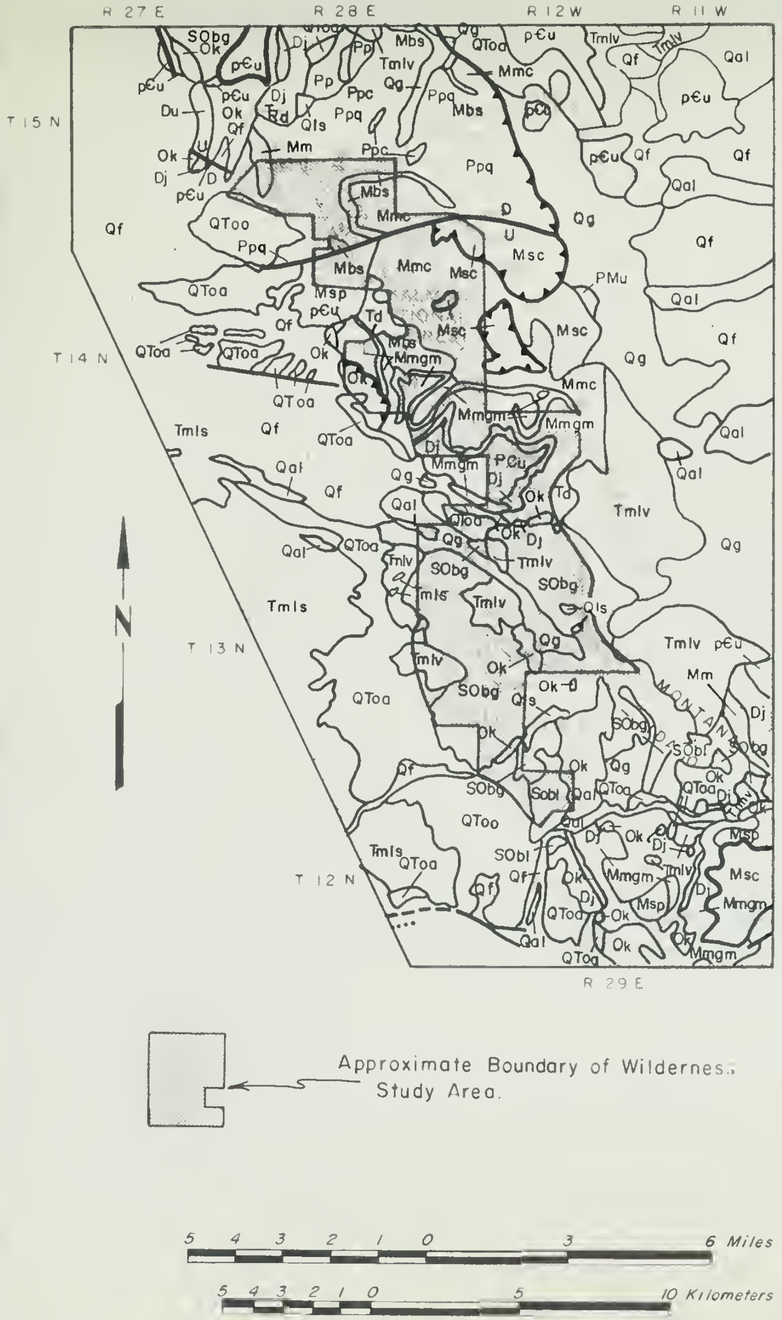

Source: Rember and Bennett (1979)

SEDIMENTARY | IGNEOUS

Cenozoic

- Qg Glacial deposits
- Qal Alluvium — Qls Landslide debris — Recent
- Qf Alluvial fans — Pleistocene
- QToa Older alluvium — Pliocene
- Tmls Medicine Lodge Beds — Tmlv Medicine Lodge Volcanics — Oligocene
- Td Mafic Dikes — Eocene

Mesozoic

- Ŧd Dinwoody Formation — Triassic

Paleozoic

- Pp Phosphoria Formation — Permian
- Ppc Park City Formation — Permian
- PMu Permian to Mississippian Rocks, undifferentiated.
- Ppq Quadrant Formation — Pennsylvanian
- Mu | Msc, Msp, Mmgm | Mbs, Mmc, Mm — Mississippian

Mu – Undifferentiated Mississippian Rocks

Msc – South Creek and Surrett Canyon Formations

Mmc – Mission Canyon Formation

Mm – Madison Group

Mbs – Big Snowy Formation

Msp – Scott Peak Formation

Mmgm – McGowan Creek and Middle Canyon Formation

- Dj Jefferson Dolomite — Devonian
- Ok Kinnikinic Quartzite — SObg/SObl Beaverhead Pluton — Ordovician

Pre-Cambrian

- p€u Undifferentiated Metasediments — Precambrian Y
- p€sa Swauger Quartzite — Precambrian Y

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REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA, Idaho-Montana Geologic Map

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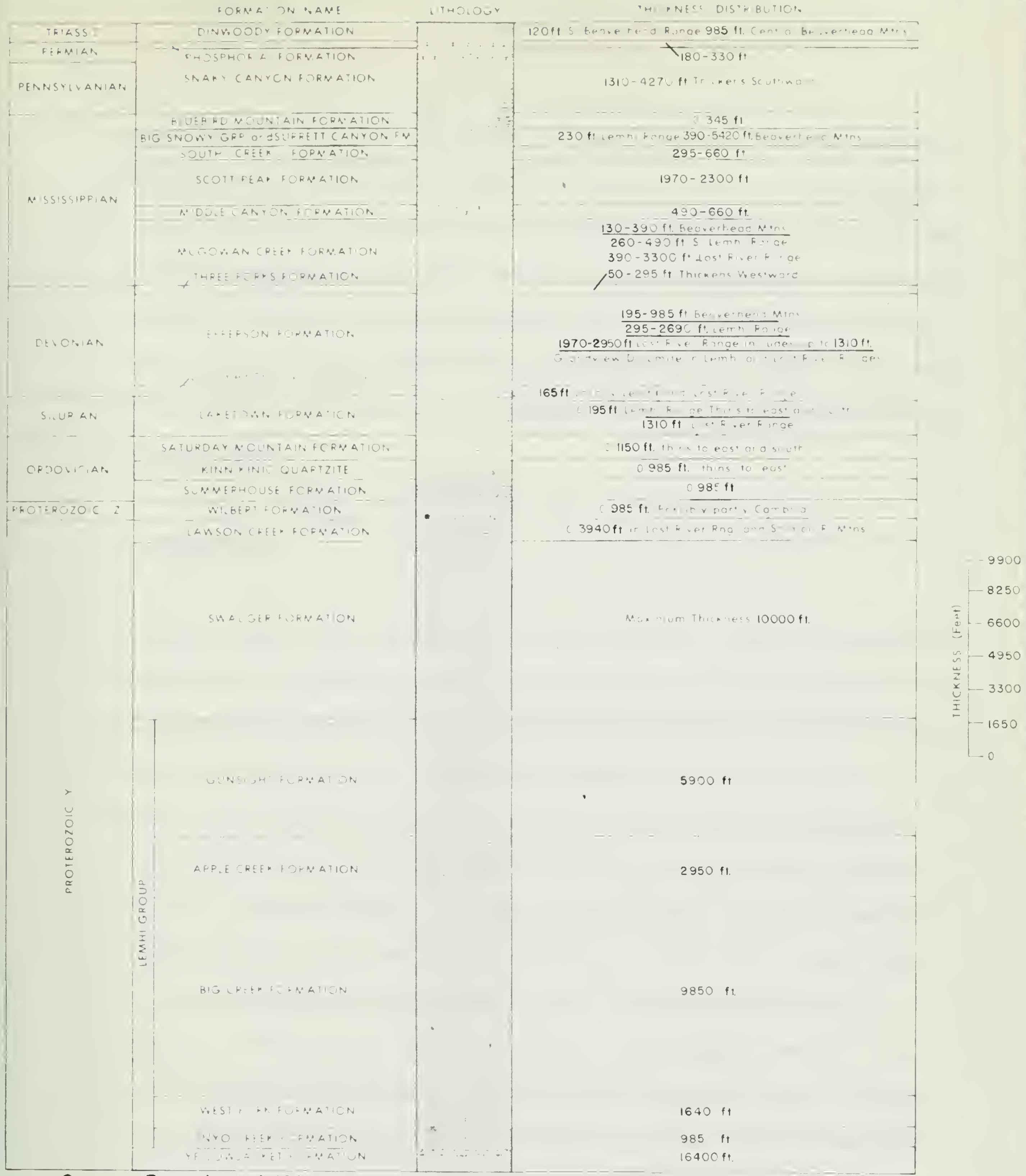

		FORMATION NAME	LITHOLOGY	THICKNESS DISTRIBUTION
TRIASSIC		DINWOODY FORMATION		120 ft S. Beaverhead Range 985 ft. Central Beaverhead Mtns
PERMIAN		PHOSPHORIA FORMATION		180-330 ft
PENNSYLVANIAN		SNAKY CANYON FORMATION		1310-4270 ft Thickens Southward
MISSISSIPPIAN		BLUEBIRD MOUNTAIN FORMATION		0 345 ft
		BIG SNOWY GRP or dSURRETT CANYON FM		230 ft Lemhi Range 390-5420 ft. Beaverhead Mtns
		SOUTH CREEK FORMATION		295-660 ft
		SCOTT PEAK FORMATION		1970-2300 ft
		MIDDLE CANYON FORMATION		490-660 ft.
		MCGOWAN CREEK FORMATION		130-390 ft. Beaverhead Mtns 260-490 ft S. Lemhi Range 390-3300 ft Lost River Range
		THREE FORKS FORMATION		50-295 ft Thickens Westward
DEVONIAN		JEFFERSON FORMATION		195-985 ft Beaverhead Mtns 295-2690 ft. Lemhi Range 1970-2950 ft Lost River Range includes up to 1310 ft. Grandview Dolomite in Lemhi and Lost River Ranges
		[illegible]		165 ft [illegible] Lost River Range
SILURIAN		LAKETOWN FORMATION		0 195 ft Lemhi Range Thins to east and south 1310 ft Lost River Range
ORDOVICIAN		SATURDAY MOUNTAIN FORMATION		0 1150 ft. thins to east and south
		KINNIKINIC QUARTZITE		0 985 ft. thins to east
		SUMMERHOUSE FORMATION		0 985 ft
PROTEROZOIC Z		WILBERT FORMATION		0 985 ft. Possibly partly Cambrian
PROTEROZOIC Y		LAWSON CREEK FORMATION		0 3940 ft in Lost River Rng and S[illegible] Mtns
		SWAUGER FORMATION		Maximum Thickness 10000 ft.
	LEMHI GROUP	GUNSIGHT FORMATION		5900 ft
		APPLE CREEK FORMATION		2950 ft.
		BIG CREEK FORMATION		9850 ft.
		WEST FORK FORMATION		1640 ft
		INYO CREEK FORMATION		985 ft
		YELLOWJACKET FORMATION		16400 ft.

Source: Ruppel et al., 1981

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA, Idaho-Montana Stratigraphic Column

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characterized by long linear, northwest-trending mountain ranges separated by intervening valleys (Ruppel, 1982). Elevations range from about 3,500 feet in Birch Creek and Lemhi Valleys to nearly 11,000 feet along the crest of the Beaverhead Mountains which marks the continental divide. The streams draining to the west are typically short with steep gradients and narrow V-shaped valleys. The streams draining to the east are longer; have a more gentle gradient and broader, flat-bottomed valleys reflecting a more mature drainage pattern.

2.3 Rock Units

The oldest rocks in the Eighteen Mile GRA belong to a group of Precambrian Y (1600-600 m.y.) sedimentary rocks which crop out in a 150 mile long belt in east-central Idaho from the Snake River Plain northward to the Idaho-Montana border at Lost Trail Pass. These rocks consist of a thick sequence of impure grayish-green fine-grained feldspathic quartzites and argillitic siltites belonging to the Lemhi Group and the overlying Swauger Formation (Fig. 5). The Lemhi Group is divided into five units: (1) the Inyo Creek Formation (oldest), (2) the West Fork Formation, (3) the Big Creek Formation, (4) the Apple Creek Formation, and (5) the Gunsight Formation (youngest). Thickness of the Lemhi Group is about 20,000 feet and the Swauger Formation is at least 10,000 feet thick (Ruppel, 1975). Correlation of these rocks with the Belt Supergroup in western Montana and northern Idaho is tenuous because of differing characteristics between the two sequences as a result of differing depositional conditions. The Belt Group was deposited in the Belt basin whereas the east-central Idaho rocks were deposited in the Belt miogeocline. Ruppel (1975) suggests that on the basis

of lithology, the Apple Creek Formation may be the equivalent of the middle belt carbonates belonging to the Wallace Formation and the Helena Dolomite. Additionally, striking differences between the Swauger Formation and the underlying Lemhi Group may reflect tectonic adjustments that took place during Missoula time; thus, the Swauger would be equivalent to part or all of the Missoula Group and the Gunsight Formation at the top of the Lemhi Group could be equivalent to part of the Wallace Formation (Ruppel, 1975).

The overlying Swauger Formation, also Precambrian Y, consists of grayish-pink to pale-purple or pale-red-purple and less commonly light brown to grayish-green hematitic quartzite that is only slightly feldspathic. Beds within the unit are 3-6 feet thick, often prominently and coarsely cross-bedded, and occasionally, rippled marked. Quartz grains are vitreous, well-sorted and well-rounded. The beds, particularly in the lower part of the formation, are separated by partings and beds, generally up to six inches thick but rarely up to three feet thick, of greenish-gray to dark-grayish-green siltite or argillite. A purplish speckling or blotching from hematite is characteristic of weathered Swauger. An extensive unconformity is present at the top of the formation which results in thickness ranges from 0 to 1,000 feet (Ruppel, 1975).

The Lemhi Group and the Swauger Formation are widely exposed along the crest and west side of the Beaverhead Mountains in the vicinity of the Eighteen Mile GRA, but they have not been mapped in detail. Rocks belonging to the Apple Creek, Gunsight, and Swauger Formations crop out in the upper reaches of Hawley Creek, about 5 miles north of the GRA (Ruppel, 1975). In the vicinity of Clear Creek (sec. 12, T.14N., R. 28E.), Smith (1961) describes a

section of red, gray, brown and buff fine- to coarse-grained quartzose graywackes and subordinate beds of green sandstone and maroon micaceous siltstone. These rocks closely resemble those in the Hawley Creek area (Ruppel, 1975). Another similar section of rocks was mapped in the vicinity of Eighteenmile Peak (sec. 21, T.13N., R.29E.) by Scholten and Ramspott (1968).

In east-central Idaho, a confusing and controversial sequence of calcareous sandstones, shales and quartzitic rocks is present between the Precambrian Y rocks and the Middle Ordovician (479-450 m.y.) Kinnikinic Quartzite. The discovery of Early Ordovician (500-479 m.y.) fossils in the upper part of the sequence, along with recognition of angular unconformities at the base, middle and top of the sequence, has resulted in the separation of the sequence into the Wilbert Formation, tentatively of Precambrian Z (800-600 m.y.) age, and the Summerhouse Formation of Early Ordovician age (Ruppel et al., 1975).

The Wilbert Formation is dominately brownish-gray to pale-red quartzitic fine to coarse sand, grit, or conglomerate. The unit is poorly sorted, partly laminated and cross-laminated, hematitic, occasionally glauconitic, and partly calcareous. A few beds of sandy limestone and dolomite as well as a few beds of siltstone, shale and fine-grained quartzite are present in the upper Wilbert. Thickness of the unit ranges from 0 to about 1,000 feet (Ruppel et al. 1975). The Wilbert is known to be present some 35 miles southeast and about 60 miles northwest of the Eighteen Mile GRA, but its distribution in the vicinity of the GRA is not known.

The overlying Summerhouse Formation appears to represent a near-shore, perhaps lagoonal environment; thus, the unit differs widely in lithology and thickness from place to place. The type section for the Summerhouse is on the east wall of Summerhouse Canyon (SE$\frac{1}{4}$, SE$\frac{1}{4}$, sec. 25, T.12N., R.25E.) in the Lost River Range. In the Beaverhead Range, the only known occurrence of the Summerhouse is at Maiden Peak, about 25 miles north of the Eighteen Mile GRA. At Maiden Peak, the Summerhouse is characterized by Scolithus-bearing, glacuonitic, calcareous and dolomitic, brownish to reddish quartzitic sandstones. This section is about 250 feet thick. It may be part of a thrust slice; thus, its basal contact could be a fault. Conodonts from the Summerhouse Formation near North Creek, about 33 miles southeast of the type section, indicate an Early Ordovician age for the formation (Ruppel et al., 1975).

The Kinnikinic unconformably overlies older rocks in the southern Beaverhead Mountains (Scholten and Ramspott, 1968). The older rocks are in angular unconformity with the overlying Kinnikinic Quartzite. The rocks in the Kinnikinic are white to gray to lavender, hard, dense orthoquartzites composed of well sorted, subrounded to well rounded, quartz grains with traces of zircon, tourmaline, magnetite and orthoclase. Interstitial to the clasts are small amounts of matrix material composed of sericite, illite and hematite. The rock is cemented by overgrowths of quartz, plus traces of hematite and calcite. The cement has produced a rock low porosity except locally where secondary porosity has formed by the dissolution of carbonate. The unit is medium- to thick-bedded and locally laminated. Very few primary sedimentary structures are present. The Kinnikinic ranges from 0 to 985 feet thick in the southern Beaverhead Mountains (Scholten and Ramspott,

1968). Fossil evidence from the southern Lemhi Range indicates a Middle (479-450 m.y.) or Late Ordovician (450-500 m.y.) age for the Kinnikinic (Ross, 1961).

Both the Jefferson and Three Forks Formations thin drastically in the Beaverhead Range due to overlap onto a lower Paleozoic topographic high known as the Lemhi arch; therefore, the two units are mapped together in the Beaverhead Range (Ruppel, 1978). In the Beaverhead Mountains, the Jefferson is in disconformable contact with the Kinnikinic Quartzite and older rocks. The Jefferson consists of a lower limestone member and an upper dolomite member. The base of the lower member is marked by a unit of sandy or conglomeratic material and carbonate breccia. Pebbles derived from underlying units are common in this interval. The limestone member is dark-brown, dense and dolomitic. In many places a characteristic gray to tan, highly porous, red, yellow, and brown weathering limestone is present. The pores are often filled with a light-gray silty, calcareous matrix. The upper member is medium- to dark-gray or brown calcareous dolomite. It weathers to light-gray or buff. The overlying Three Forks, in southwestern Montana, consists of thin-bedded to platy calcareous shales and siltstones, and shaley limestones and dolomites. Typically these rocks weather yellow-brown. Locally in the Beaverhead Range, dark-gray argillaceous limestones are dominant in the Three Forks (Scholten and Hait, 1962). The thickness of the two units ranges from about 100 to 300 feet, but the Jefferson, particularly the lower limestone member, may be absent locally (Skipp and Hait, 1977; Scholten and Hait, 1962). Stratigraphic evidence suggests that the Jefferson in the Beaverhead Range is entirely Late Devonian (360-345 m.y.),

and fossil evidence from the Three Forks indicate that it is also Late Devonian (Scholten and Hait, 1962).

Early Mississippian (345-322 m.y.) rocks unconformably overlie Late Devonian rocks throughout most of Idaho (Skipp et al., 1979) including the Eighteen Mile GRA. The youngest Mississippian unit is the McGowan Creek Formation which regionally consists of a lower member of orogenic detritus, specifically fine-grained, thinly bedded turbidites, and an upper member of calcareous siltstone interbedded with silty micritic limestone, probably a starved-basin facies. The turbidite sequence ranges in thickness from about 100 feet in the Beaverhead Mountains to about 4,000 feet in the White Knob Mountains. The upper member of the McGowan Creek ranges in thickness from 200 to almost 500 feet (Skipp et al., 1979) and is not present in the southern Beaverhead Range (Skipp and Hait, 1977). In the Eighteen Mile GRA the McGowan Creek Formation is present, but not described in detail. In the adjacent southern Lemhi Range it consists dominately of dark-gray to black carbonaceous shale with some fine-grained siltstone. Interbeds of black chert are common (Ross, 1961). Thickness of the McGowan Creek ranges from 100 to 390 feet in the Beaverhead Mountains (Ruppel et al., 1981). On the basis of conodont studies, the McGowan Creek Formation is dated as Early Mississippian.

The McGowan Creek Formation is conformably overlain by carbonate bank and forebank deposits belonging to the Middle Canyon (oldest), Scott Peak, South Creek, and Surrett Canyon Formations (youngest). The type sections for these units occur in the adjacent southern Lemhi Range (Huh, 1967). These formations represent a prograding carbonate-bank complex which generally

thickens westward. Thicknesses range from 1,280 to 4,225 feet (Skipp et al., 1979). The basal part of the complex, the Middle Canyon Formation, is a thin-bedded, dark-gray cherty, fine-grained limestone in the upper part and a light-brown weathering, calcareous quartz siltstone to fine sandstone in the lower part. In the Beaverhead Range, the Middle Canyon ranges from about 500 to 650 feet in thickness (Ruppel et al., 1981) and it represents in part, the forebank deposit formed in front of the prograding bank (Skipp et al., 1979). The succeeding Scott Peak Formation (1,970 to 2,300 feet thick in the Beaverhead Mountains) consists of an upper and lower crinoid bryozoan calcarenite and cyclically intebedded cherty, crystalline limestone with an intervening medial massive medium- to medium-dark-gray mixed crystalline limestone. The overlying South Creek Formation (about 650 feet thick in the Beaverhead Range) is a thin-bedded alteration of fine-grained, dark limestone with 3 to 6 inch chert beds and 1 to 2 inch beds of clayey to silty, dark, fissile limestone. The uppermost Surrett Canyon Formation is thin or missing in the Beaverhead Mountains. The Scott Peak and Surrett Canyon Formations represent a carbonate-bank accumulation whereas the intervening South Creek Formation indicates a period of relatively deep water marine circulation that temporarily interrupted carbonate-bank buildup (Skipp et al., 1979). Fossil evidence indicates that all of the units belonging to the carbonate-bank complex are Late Mississippian (332-310 m.y.) in age (Huh, 1967; Skipp et al., 1979).

In the southern Beaverhead Mountains, the South Creek Formation is gradationally overlain by the Big Snowy Formation. The Big Snowy consists of black shale, siltstone, fine-grained calcareous sandstone, and phosphatic carbonate conglomerate. The shales weather medium-gray. The Big Snowy

ranges from 300 to about 600 feet in thickness and marks the termination of carbonate-bank buildup. A diverse fauna of brachiopods, bryozoans, mollusks, corals, ostracods, conodonts, algae, and foraminifers recovered from carbonate lenses indicate that the Big Snowy is Late Mississippian (Skipp et al., 1979).

In the southern Beaverhead Range, the Bluebird Mountain Formation gradationally overlies the Big Snowy Formation. The type section of the Bluebird is on the west flank of Gallagher Peak in the southern Beaverhead Mountains. At the type section, the Bluebird consists of medium-gray to medium-light-gray, very fine-grained, quartzose, mostly thin-bedded, cliff-forming sandstone which weathers light-brown. Minor interbeds of gray dolomite and limestone are also present. The upper contact with the overlying Snaky Canyon Formation is gradational and placed at the position in the section above which limestones are dominate. Foraminifera and the conodonts, _Gnathodus_ bilineatus and _Cavusgnathus_ sp., indicate that the Bluebird Mountain is Late Mississippian. The Bluebird Mountain is 345 feet thick at its type section (Skipp et al., 1979).

The Mississippian-Pennsylvanian contact is gradational in the Eighteen Mile GRA, and the Pennsylvanian rocks are represented by the lower part of the recently defined Snaky Canyon Formation (Skipp et al., 1979) which is comprised of the basal Bloom Member, the succeeding Gallagher Peak Sandstone Member, and the lower part of the overlying Juniper Gulch Member. The type sections for these formations are in the southern Beaverhead Range. The Pennsylvanian part of the Snaky Canyon ranges from 1,970 feet thick in the Arco Hills-Howe Peak area to about 3,280 feet thick in the southern

Beaverhead Mountains. The Bloom Member consists of medium-bedded gray limestone, largely sandy or silty, interbedded with thin beds of very fine-grained, yellowish-brown weathering sandstone and siltstone. Fossil evidence indicates that the Bloom Member spans Early (310-305 m.y.) and Middle Pennsylvanian (305-290 m.y.) time. The overlying Gallagher Peak Sandstone Member, less than 200 feet thick, is dominately a very fine-grained calcareous sandstone. It is probably Late Pennsylvanian (290-280 m.y.) in age. The uppermost member of the Snaky Canyon Formation, the Juniper Gulch, spans the Pennsylvanian-Permian (280-230 m.y.) boundary without any major depositional change. The boundary is near the middle of the member in a 330-600 foot hydrozoan(?) algal buildup. The Juniper Gulch Member consists of interbedded sandy and cherty, generally light-gray weathering, thin- to thick-bedded limestone and dolomite. Sand and chert is most common in the basal 300 feet (Skipp et al., 1979).

The Early Permian (280-251 m.y.) Phosphoria Formation conformably overlies the Snaky Canyon Formation. In the southern Beaverhead Range, the Phosphoria is divided into: (1) the basal Meade Peak Member, a siltstone; (2) the succeeding Rex Chert Member, an interbedded grayish-black chert and light-gray to medium-gray dolomite; (3) the Retort Phosphatic Shale Member consisting of grayish, fine-grained oolitic phosphorite, brownish-gray, sandy dolomite, and brownish laminated siltstone; and (4) the Tosi Chert Member, a dark-gray or black, ledge-forming chert with medium-gray, oolitic phosphatic limestone interbeds. The Franson Tongue (of the Park City Formation) is present between the Rex Chert and Retort Phosphatic Shale Members. The tongue is composed of interbedded limestone and dolomite with minor chert. The carbonates of the Franson Tongue are locally sandy and

cherty. The Phosphoria is about 285 feet thick in the southern Beaverhead Mountains. The brachiopod Orbiculoidea sp. occurs in all facies of the Phosphoria and Orbiculoidea cf O. missouriensis and Cancrinella cf C. phosphatica are present in the siltstone and phosphorite belonging to the Retort (Skipp et al., 1979).

Conformably overlying the Phosphoria Formation is the Triassic (230-195 m.y.) Dinwoody Formation (Moritz, 1951). It is composed of a basal part consisting of shaly and fissile siltstone, yellow-tan to light-brown, with minor beds of fossiliferous limestone that weather to a distinctive brownish-gray. The upper part of the formation consists of shaly and fissile siltstone with more abundant limestone beds and interbedded calcareous siltstone (Lucchitta, 1966). The thickness of the Dinwoody Formation in the southern Beaverhead Range is estimated to be about 120 feet (Ruppel et al., 1981).

Overlying the Dinwoody Formation with angular unconformity is a sequence of Eocene (55-38 m.y.) volcanic rocks correlative with the Challis (Ruppel, 1978) or possibly the Medicine Lodge Volcanics (Scholten and Ramspott, 1968). These rocks are principally exposed in the southern and eastern part of the Eighteen Mile GRA adjacent to Eighteenmile Creek and peripheral to the Beaverhead Pluton. These volcanics are predominately aphanitic to porphyritic andesite and basalt with local interbeds of tuff and agglomerate. The basalt and andesite are typically pyroxene-bearing with minor interbedded olivine-bearing rocks. The phenocrysts consist of plagioclase, augite, hypersthene or enstatite and olivine. The agglomerate contains fragments of Beaverhead granite.

Tuffaceous sedimentary rocks named the Medicine Lodge beds by Scholten and Ramspott (1968) occur along the western edge of the Eighteen Mile GRA and along Nicholia Creek. These rocks overlie the Challis Volcanics to the west (Ruppel, 1978). The rocks consist of a sequence of shale, siltstone, tuff, bentonite, sandstone, pebble conglomerate, and local lignite. An upper limey part consists of limestone, tuffaceous limestone and calcareous cross-bedded tuff (Scholten and Ramspott, 1968). Some scoraceous basalt occurs interbedded within the sequence. Staatz (1979) indicates these tuffaceous sedimentary rocks were deposited in post-deformational topographic basins in mid-Tertiary time. Scholten and Ramspott (1968) report over 5,000 feet of these sediments in Nicholia basin.

Intrusive rocks in the Eighteen Mile GRA are dominated by bodies of the Silurian-Ordovician(?) Beaverhead pluton (Ramspott, 1962). The main body of the pluton is exposed north of Willow Creek and smaller bodies are found to the south near the Viola mine. Two phases are present: (1) the main granitic phase and (2) a subordinate leucosyenite (Scholten and Ramspott, 1968; Staatz et al., 1972). The main granitic phase of the Beaverhead Pluton is a pink, medium- to coarse-grained rock with considerable textural variation. The modal composition generally consists of 30% quartz, 65% alkali feldspar with albite constituting less than one-third of the total feldspar. Potash feldspar is usually untwinned microcline. Other minerals present in minor amounts are, zircon, apatite, sericite, hematite, magnetite, chlorite and limonite. The leucosyenite, possibly a border phase, is pink, medium- to coarse-grained, and composed of between 80 to 95% microcline-albite microperthite and cryptoperthite. Other minerals present in amounts of generally less than 5% include quartz, biotite, zircon and

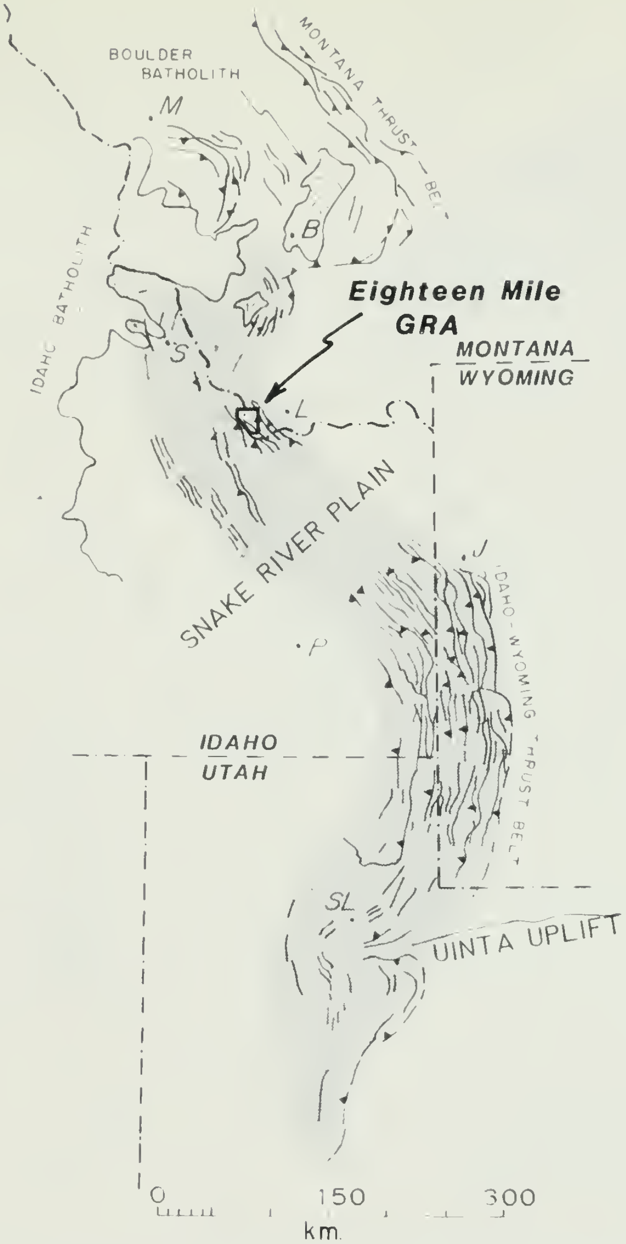
apatite. Traces of sericite, hematite, leucoxene, limonite and magnetite are also present (Scholten and Ramspott, 1968).

Numerous small ultramafic to mafic dikes and sills present in the area are thought to be part of the Medicine Lodge-Challis volcanic episode (Scholten and Ramspott, 1968; Staatz, 1979). These rocks are dark gray to dark greenish gray aphanitic and probably are basaltic to andesitic in composition. Sparse phenocrysts of olivine, augite and biotite are present (Scholten and Ramspott, 1968).

The layered and intrusive rocks of the GRA are overlain by Pleistocene (2-0.1 m.y.) and Holocene (0.1 m.y. to present) alluvium, alluvial fans, and landslide deposits (Scholten and Ramspott, 1968).

2.4 Structural Geology and Tectonics

Regionally the Eighteen Mile GRA is within the frontal Sevier orogenic belt of the Cordilleran fold-thrust belt (Fig. 6). In the area northwest of the Snake River Plain and east of the Idaho batholith, a minimum of nine major allochthons are recognized including (from west to east): the Wood River, Milligen, Copper Basin, White Knob, Lost River-Arco Hills, Lemhi, Beaverhead, Medicine Lodge and Tendoy allochthon (Fig. 7). Each of these allochthons has an internally consistent stratigraphy that differs from adjacent plates. All of the allochthons, except the structurally highest Wood River, are bounded above and below the thrust faults. The allochthons can be grouped into three stacks consisting of: (1) the Pioneer or western stack, structurally the highest, comprising the Wood River, Milligen and



Structural trends in the frontal Sevier orogenic belt, (stippled), Utah-Montana. Principal folds trends shown by lines; teeth on major thrust faults. M=Missoula; B=Butte, S=Salmon, L=Lima, P=Pocatello; J=Jackson; SL=Salt Lake City.

Data by: Beutner (1977)

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Eighteen Mile GRA, Idaho

Regional Structural Setting

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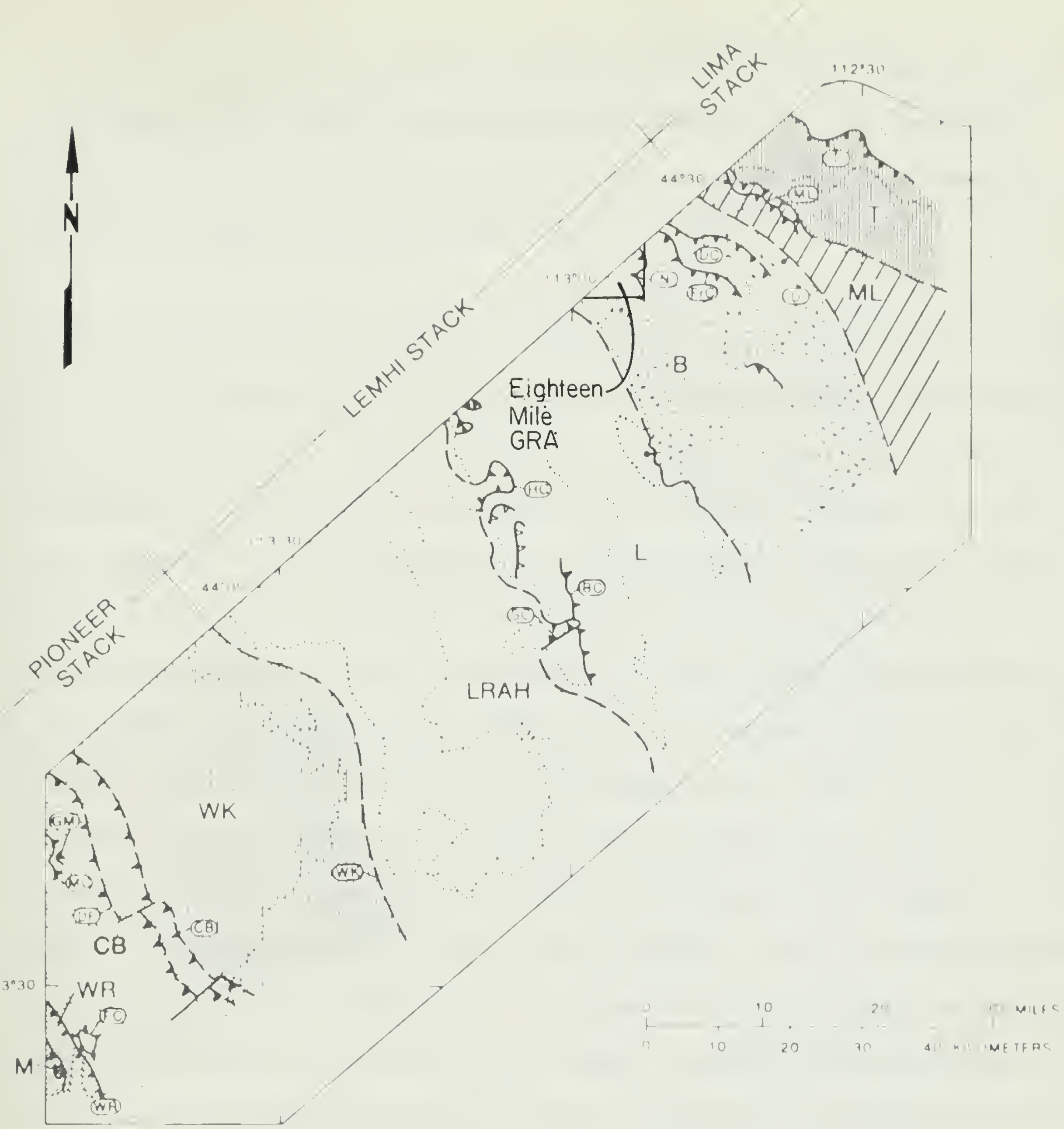

Figure 2 Map showing location and extent of allochthons along northeast margin of Snake River Plain. WR = Wood River, M = Milligen, CB = Copper Basin, WK = White Knob, LRAH = Lost River Arco Hills, L = Lemhi, B = Beaverhead, ML = Medicine Lodge (restricted), T = Tendoy and related plates. Dotted lines outline the mountain ranges (ref fig. 3). Faults identified on map are: WR = Wood River thrust, FC = Fish Creek thrust, GM = Glide Mountain thrust, MC = Muldoon Canyon thrust, DF = Dry Fork thrust, CB = Copper Basin thrust, WK = White Knob thrust, SC = South Creek thrust, HC = Horse Creek thrust, BC = Black Canyon thrust, N = Nicholia thrust, FrC = Fritz Creek thrust, DC = Divide Creek thrust, D = Deadman normal fault, ML = Medicine Lodge thrust, T = Tendoy thrust.

Source: Skipp and Hait, 1977

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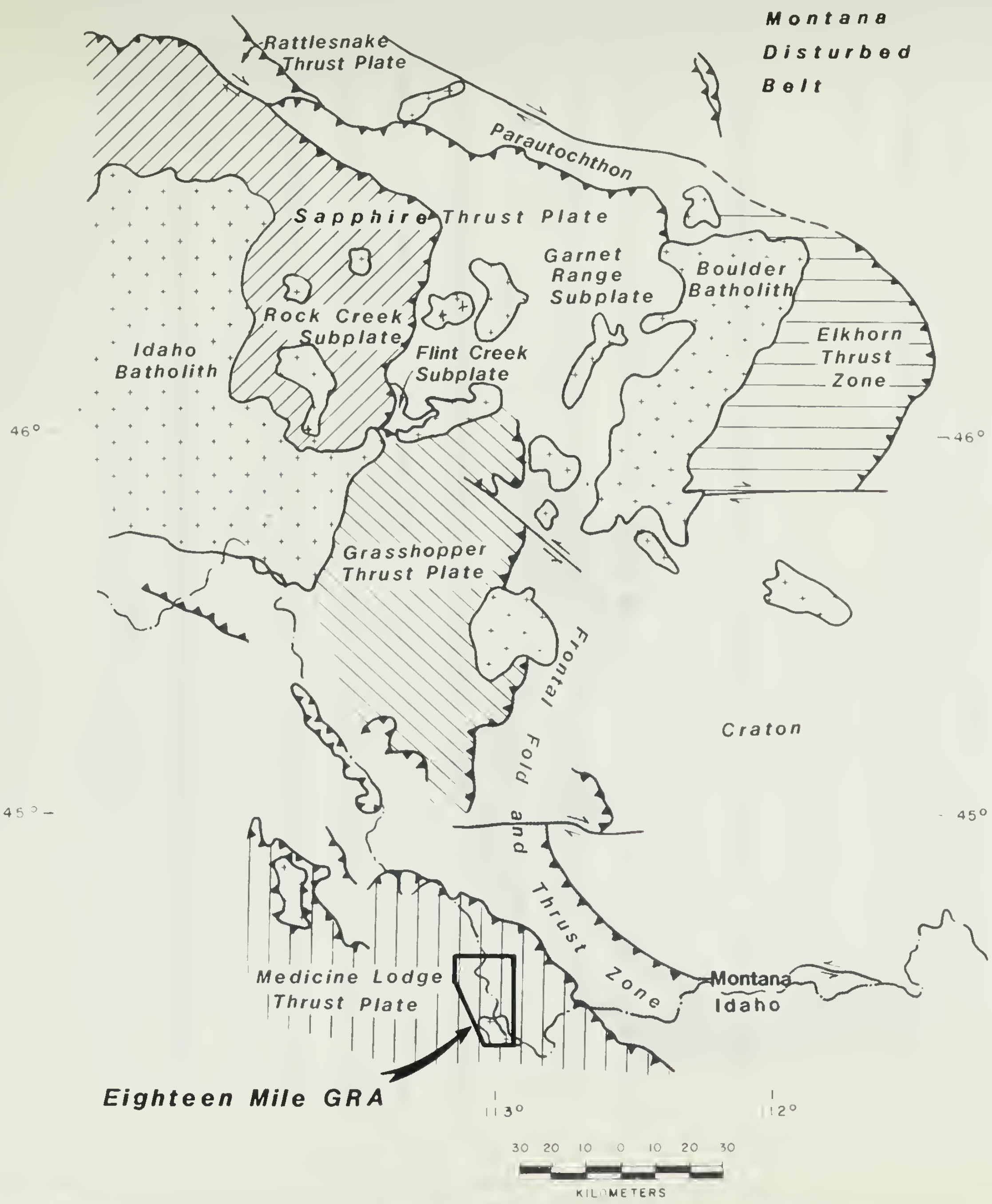
Eighteen Mile GRA, Idaho-Montana Local Structural Setting

9 83

Copper Basin allochthons, (2) the Lemhi or middle stack comprising the Lost River-Arco Hills, Lemhi, and Beaverhead allochthons, and (3) the Lima or eastern stack, structurally the lowest, comprising the Medicine Lodge and Tendoy allochthons (Skipp and Hait, 1977).

The Eighteen Mile GRA is within the Lemhi stack of allochthons (Fig. 7) as defined by Skipp and Hait (1977) or the Medicine Lodge Plate as defined by Ruppel et al. (1981). The allochthons in the Lemhi stack contain thick sequences of Precambrian Y rocks overlain locally by Precambrian Z rocks. The Precambrian rocks are overlain by thick Paleozoic miogeoclinal sequences which exhibit a general resemblance to each other from allochthon to allochthon. The Lemhi stack is underlain by a major thrust zone within the Precambrian Y sequence (Skipp and Hait, 1977). This major thrust is the Medicine Lodge thrust system (Fig. 8) of Ruppel et al. (1981) and is probably a major segment of the Cordilleran fold-thrust belt; thus, it is comparable to the Bannock thrust system in southeastern Idaho (Ruppel, 1978). The Medicine Lodge plate is widely exposed in east-central Idaho and in the Big Hole basin of Montana. It probably extends northwest to the east edge of the Idaho batholith which was probably emplaced after thrusting. In the Beaverhead Mountains the basal zone of the Medicine Lodge plate is well exposed in a few places. The zone consists of 300 to 1,000 feet of intensely sheared, brecciated and mylonitized rocks. Above the basal zone the structures in the plate consist of tight asymmetrical and overturned folds broken by closely spaced interlacing imbricate thrusts that dip into the basal decollement (Ruppel et al., 1981). Preliminary unstacking of the allochthons indicates a total movement of 125 to 150 miles, but relative



Map adapted from Ruppel, et.al. (1981)

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Eighteen Mile GRA,
Idaho-Montana
Montana Thrust Belt

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movements between the Lost River-Arco Hills, Lemhi and Beaverhead allochthons appears to be small (Skipp and Hait, 1977).

The Eighteen Mile GRA is within the Beaverhead allochthon (Fig. 7) which occupies a position between the thrust system along the west flank of the Beaverhead Mountains and the buried trace of the Deadman normal fault. The Deadman fault is located in the general position of Medicine Lodge Creek just west of the trace of the Medicine Lodge thrust. The Beaverhead allochthon is 17 miles wide at the surface and more than 5,000 feet thick. The allochthon is extensively imbricated along the eastern margin. Imbrications such as the Divide Creek, Fritz Creek, and Nicholia thrusts are displaced by east- and northwest-trending faults. These faults are in turn displaced by north-northwest trending range-front faults (Skipp and Hait, 1977).

The Beaverhead Range is described by Scholten and Ramspott (1968) as a flat-topped uplift flanked by monoclinically folded limbs cut by steep faults. The axial part of the range is underlain by nearly flat, pre-uplift thrust faults that steepen on the range flanks to as much as 80° (Ruppel, 1982). Ruppel (1982) interprets this structure to be the result of drape folds formed over the edges of rising basement blocks. During the folding process movements were accommodated along slip surfaces within the imbricate thrust faults and along the thick Medicine Lodge decollement, as well as by slip between beds within shaly formations. The normal range-front faults are consequently thought to be minor secondary faults formed by gravitational collapse and sliding of blocks of strata from the steepened monoclinal limbs of the uplifts into the adjacent valleys. A consequence of

this interpretation is that the intervening valleys, such as Lemhi Valley and Birch Creek Valley are flat bottomed basins flanked by steep reverse faults. Gravity surveys (Kinoshita et al, 1976) indicate that the Lemhi-Birch Creek trench is deep, about 10,000 feet in its deepest part (Ruppel, 1982). The gravity data also suggests that valleys are symmetrical and deepest in the center which is consistent with the uplifted block hypothesis.

Faulting has continued into the Pliocene and Holocene. These young normal faults trend dominantly northwest parallel to the range fronts in east-central Idaho. Although the faults exhibit fresh and well exposed scarps displacement is small. Ruppel (1964) estimates vertical displacement on the west side of the Beaverhead Mountains north of Leadore to be on the order of 200 feet.

2.5 Paleontology

The rocks underlying the Eighteen Mile GRA are moderately fossiliferous, but no index or special localities are described. Units reported to be locally or commonly fossiliferous include the Jefferson Dolomite, the McGowan Creek Formation, the Middle Canyon-Scott Peak-South Creek Formations, the Big Snowy Formation, the Phosphoria Formation, the Dinwoody Formation, and the Medicine Lodge beds. The dolomitized stromatoporoid and tabulate coral-bearing carbonate bank deposits of the Jefferson Dolomite include many coral and braciopod genera (Skipp et al., 1979). The lower member of the McGowan Creek Formation contains scattered brachiopods, pelecypods, gastropods, cephalopods, trilobites and corals as well as conodonts (Skipp, Sandro and

Hall, 1979). Fossils present in the Middle Canyon-Scott Peak-South Creek Formations include corals, brachiopods, mollusks, bryocoans, algae, calcareous foraminifers, trilobites, ostracodes and shark teeth. The Big Snowy Formation contains some bioclastic beds composed of bryozoan, crinoid and coral hash. In addition, some Big Snowy beds contain productid, spiriferid, and rhynconellid brachiopods and corals (Scholten and Ramspott, 1968). Brachiopods are prevalent throughout the Phosphoria Formation (Oberlindacher and Hovland, 1979). Fossils commonly found in the Dinwoody Formation include conodonts, brachipods and ammonites. The Medicine Lodge beds contain numerous plant and vertebrate fossils. Plant fossils found in the unit include; Ginkgo, Metasequoia, Sassafras, and Symphicarpos. Vertebrate fossils found in the Medicine Lodge beds include rhinoceras teeth, fish bones, and horses (parhippus and merrychippus).

2.6 Historical Geology

During Precambrian Y time, the Eighteen Mile GRA was located on a high area separating the Belt basin in northern Idaho and northwestern Montana from the Cordilleran miogeocline. The sediments comprising the Lemhi Group rocks were deposited in the miogeocline 150 to 200 miles southwest of the Lemhi Range. The change from fine-grained feldspathic quartzite in the Gunsight Formation to medium-grained, hematitic, non-feldspathic quartzite in the Swauger Formation may reflect the major tectonic adjustments of early Missoula time (Ruppel, 1975). The pronounced unconformity between the Swauger Formation and the overlying Precambrian Z Wilbert Formation reflects major deposition and erosion of the Precambrian Y rocks. Regional uplift,

folding, and some faulting ended sedimentation in the Precambrian Y miogeocline, and is probably closely related to deformation associated with the East Kootenay orogeny in Canada about 800 m.y. ago (Ruppel et al., 1975).

The Precambrian Z Wilbert Formation was deposited in a near-shore environment. The northward thinning recognizable in the Lemhi Range reflects both on-lap and Late Cambrian emergence and erosion. The shoreline was probably over 100 miles west of the Eighteen Mile GRA (Ruppel et al., 1975).

Formerly, south-central Idaho was thought to have been a relatively stable miogeosynclinal area during early Paleozoic time, but evidence of an Ordovician disturbance is accumulating (Skipp, 1981). The Early Ordovician Summerhouse Formation, present west of the Beaverhead Range, represents a near-shore perhaps lagoonal environment. The Summerhouse is overlain in slight angular unconformity by the Kinnikinic Quartzite (Ruppel et al., 1975) which indicates a period of emergence and folding. In addition, an intrusive complex in the southern Beaverhead Mountains is dated as latest Early Ordovician and syndepositional faulting in the Kinnikinic Quartzite is desribed in the same area (Skipp, 1981).

During lower Paleozoic time, the Eighteen Mile GRA was encompassed by the Lemhi arch, a northwest-trending intermittently emergent landmass that separated the Cordilleran miogeocline in western Idaho from a shelf embayment in southwestern Montana. During this time, the eastern side of the arch was probably continuous with the large landmass to the east since Ordovician and Silurian rocks are absent (Ruppel, 1978). The Middle Ordovician through Siluran rocks to the west of the Eighteen Mile GRA are

characteristic of a shallow, very gradually deepening sea. The Kinnikinic, a near-shore clean sand probably derived from a mature landmass to the east, is succeeded by reefal dolomites (Ross, 1947). Sometime toward the end of Silurian or beginning of Early Devonian time the seas withdrew from southeast Idaho and a widespread erosion surface developed, exposing successively older rocks (from Silurian to Cambrian) in an easterly direction (Scholten and Hait, 1962).

Beginning in Middle Devonian time a deep basin developed in central Idaho. To the east, a miogeosyncline developed which eventually became distinctly differentiated from the semi-stable cratonic shelf along a sharp hinge line near the present Lemhi Range. Seas were originally transgressive during all of Middle and part of Late Devonian time (Scholten and Hait, 1962).

Latest Devonian to early Mississippian time was a period of upheaval associated with the Antler orogeny. Devonian and older rocks were uplifted and eroded as the Antler highland developed in southwestern Idaho and northern Nevada (Skipp, 1981). Turbidites filled a deep and narrow flysch trough developed adjacent to the eastern margin of the Antler highland. East of the flysch trough, thick orogenic, thin starved-basin, and thick carbonate sequences were deposited in an outer cratonic platform or foreland basinal environment. Sedimentation continued without major interruption through Mississippian time (Skipp et al., 1979). The flysch basin had filled by Early Pernnsylvanian time and was succeeded by a carbonate bank. Coincident with the rise of the ancestral Rocky Mountains during Middle Pennsylvanian time, the sediments in the western portion of the flysch basin were uplifted to form the Copper Basin highland. Minor coarse detritus from

this highland was shed eastward into the shallow water carbonate bank regime of the Snaky Canyon Formation (Skipp, 1981).

The time gap between the Triassic Dinwoody Formation and the Eocene Challis Volcanics represents the Sevier orogeny. During Early Cretaceous (141-100 m.y.) to Paleocene (65-55 m.y.) the major thrust sheets developed forming the allochthonous terrane presently underlying the Eighteen Mile GRA (Skipp, 1981). Eastward telescoping due to thrusting across the northeast margin of the Snake River Plain is estimated to have produced crustal shortening in excess of 180 miles, and possibly as much as 400 miles (Skipp and Hait, 1977).

The major part of the Eocene Challis Volcanics was erupted from about 51 to 45 m.y. ago. Minor volcanism and associated intrusive activity continued in the south-central Idaho region until about 40 m.y. ago. Normal and strike-slip faulting preceeded and accompanied volcanism (Skipp, 1981).

After a tectonically relatively inactive period during Oligence (38-23 m.y.) and early Miocene (23-6 m.y.) time, major basin-and-range extension faulting commenced about 17 m.y. ago. Eastward tilting of the uplifted fault blocks along moderately dipping normal faults located on their west flank formed the narrow, linear north- to northwest-trending mountain range (Skipp, 1981). The inception of basin-range faulting was followed closely by the initial downwarping and faulting of the north margin of the Snake River Plain to the south.

3.0 MINERAL AND ENERGY RESOURCES

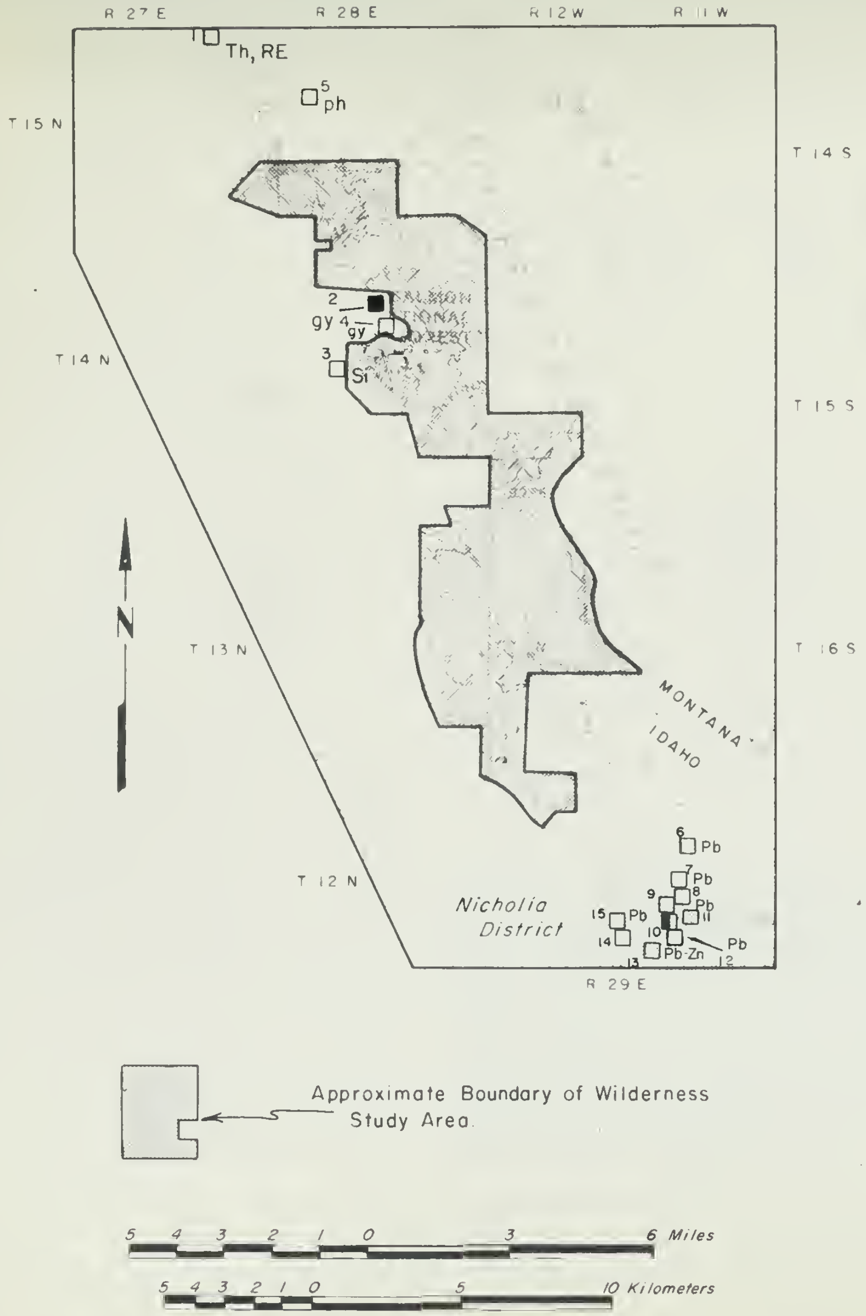
3.1 Introduction

Data on the mineral and energy resources of the Eighteen Mile GRA was compiled from all available sources. Principal sources of mineral resource information were the U.S. Geological Survey CRIB File, the U.S. Bureau of Mines MILS File, the Idaho Bureau of Mines Mines and Prospects Map Series (Mitchell et al., 1981), a mineral resource summary on Beaverhead County (Geach, 1972), and commodity reports by Kiilsgaard (1964), Johns (1980) and Withington (1964). Detailed descriptions of mineral districts in the vicinity of the GRA are given by Anderson and Wagner (1944), Staatz (1979), Staatz et al. (1972), and Oberlindacher and Hovland (1979).

Data on energy resources was obtained from both the Montana Oil and Gas Conservation Commission and the Idaho Oil and Gas Conservation Commission. Other information was obtained from Breckenridge (1982), Cole et al. (1982), Mitchell et al. (1980), and Sonderegger and Bergantino (1981). The U.S. Department of Energy conducted a study of the uranium potential of the area as part of the NURE Program (Wodzicki and Krason, 1981).

3.2 Known Mineral and Energy Deposits

Silver-lead-zinc deposits occur in the southeast corner of the Eighteen Mile GRA (Fig. 9, Table I). These deposits are in the Nicholia district which is described by Shenon (1928), Anderson and Wagner (1944), Umpleby (1913), and Ruppel (1978). Detailed geology of the Nicholia district is shown in Figure



LEGEND

■ Mineral Orebody
◧ Mineral Deposit
☐ Mineral Occurrence
⚒ Active Quarry
⚒ Inactive Quarry
✕ Active gravel or clay pit
✕ Inactive gravel or clay pit

1 ☐ Cu — occurence number — commodity

Ag - Silver
Au - Gold
Pb - Lead
RE - Rare Earths
Th - Thorium
Zn - Zinc
gy - Gypsum
si - Silica
ph - Phosphate

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REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA,
Idaho-Montana

Mineral Occurrences

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TABLE I

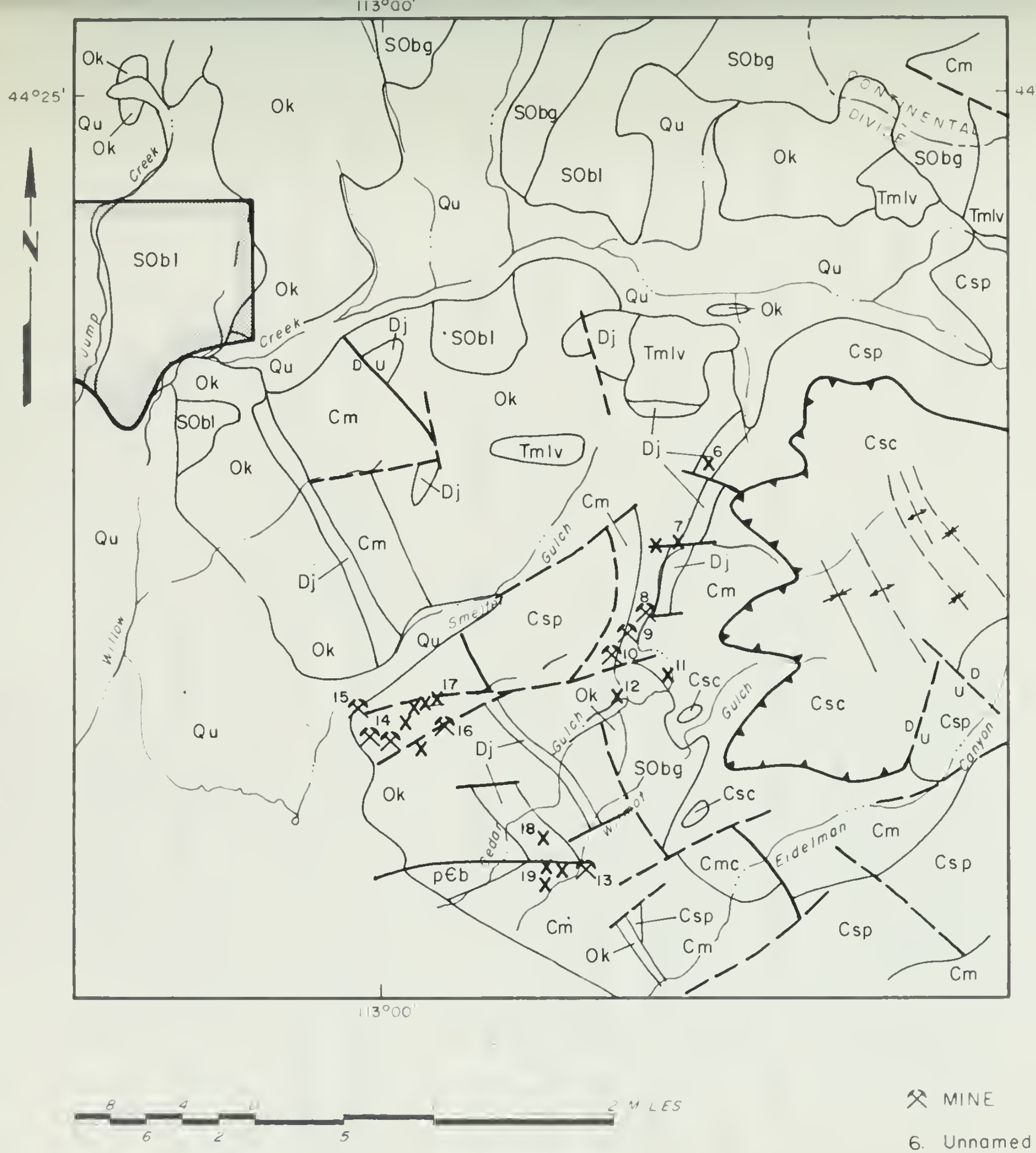
MINERAL OCCURRENCES IN THE EIGHTEEN MILE GRA

Map No.	Name	Commodity	Reference
1	Kay Claims	Thorium-RE, Zr-Ti, mon, Cu	Staatz (1982)
2	Clear Creek	Gypsum	Withington (1964)
3	Lombardi	Siliza, Qtz xtals	Mitchell et al. (1981)
4	Snowball Quarry	Gypsum	Mitchell et al. (1981)
5	Unnamed	Phosphate	Oberlindacher and Hoveland (1979)
6	Unnamed	Pb-Zn-Ag	Anderson and Wagner (1944)
7	Unnamed	Pb-Zn-Ag	Anderson and Wagner (1944)
8	Clark and Rossi	Pb-Zn-Ag	Anderson and Wagner (1944)
9	Climax Group	Pb-Zn-Ag	Anderson and Wagner (1944)
10	Viola Mine	Pb-Zn-Ag	Anderson and Wagner (1944)
11	Clipper	Pb-Zn-Ag	Anderson and Wagner (1944)
12	Ida	Pb-Zn-Ag	Anderson and Wagner (1944)
13	Erdelman	Pb-Zn-Ag	Anderson and Wagner (1944)
14	Unnamed	Pb-Zn-Ag	Anderson and Wagner (1944)
15	Unnamed	Pb-Zn-Ag	Anderson and Wagner (1944)
16	Unnamed	Pb-Zn-Ag	Anderson and Wagner (1944)

10. The Nicholia district is the northernmost part of the Birch Creek district which extends along the front of the Beaverhead Range from north of Nicholia, southeast for about 30 miles, to the edge of the Snake River Plain.

The orebodies in the Nicholia district are described as replacements in limestone. The orebodies occur as mantos, pipes or irregular masses. All the production has been from near-surface oxidized zones; typically sandy lead carbonate, zinc carbonate and copper carbonates. The unoxidized orebodies include galena, chalcopyrite, sphalerite, tetrahedrite and pyrite along with the gangue minerals siderite, barite, calcite and quartz. The galena has a fine-grained granular habit and along with chalcopyrite (where present) forms stringers, small lenses, and irregular masses. Sphalerite is only found in small amounts of widely scattered grains. Tetrahedrite and pyrite occur in microscopic amounts (Anderson and Wagner, 1944).

The Viola mine (loc. 10, Figs. 9-10, Table I) was the most important producer in the Nicholia district. It produced an estimated $2,500,000 to $5,000,000 worth of ore from 1882-1889. The major orebodies at the Viola mine were three large, irregular flat-lying bodies separated by steeper dipping zones of stringer ore. The orebodies were typically several hundred feet in horizontal dimension and ranged up to 30 feet thick. The ore consisted of silver-bearing lead oxide, primarily cerrusite, with a grade of 4 to 14 ounces of silver and 35-60% lead per ton. The lead-silver ore was underlain by smithsonite grading between 20 and 30% zinc. The smithsonite was apparently not mined (Anderson and Wagner, 1944). The Viola mine is adjoined to the north, east and south by other properties (locs. 6-9 and



Legend

Qu	Undifferentiated Quaternary Deposits
Tmlv	Medicine Lodge Volcanics
Ccs	South Creek and Surrett Canyon Limestones
Csp	Scott Peak Limestone
Cmc Cm	Milligan and Middle Canyon Sandstone and Shale / Cmc Chert Member
Dj	Jefferson Dolomite
Ok	Kinnikinic Quartzite
pЄb	Belt Sandstone Swauger Quartzite
SObg	Beaverhead Pluton Granite
SObl	Leucosyenite
	Contact
	Fault, dashed where approximate
	Thrust fault
	Syncline
	Anticline
	Boundary of WSA 43-3

⚒ MINE	× PROSPECT
6. Unnamed	13 Eidelman
7 Unnamed	14 Unnamed
8. Clark and Rassi	15. Unnamed
9 Climax Graud	16 Unnamed*
10. Viola	17 Unnamed*
11 Clipper	18. Unnamed*
12. Ida	19 Unnamed*

* Not Shown on Figure 9

Data from: Schoten and Rampspott (1968), Mitchell et.al. (1981), Anderson and Wagner (1944).

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REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA, Idaho-Montana

Nicholia Ag-Pb-Zn District Geologic Map

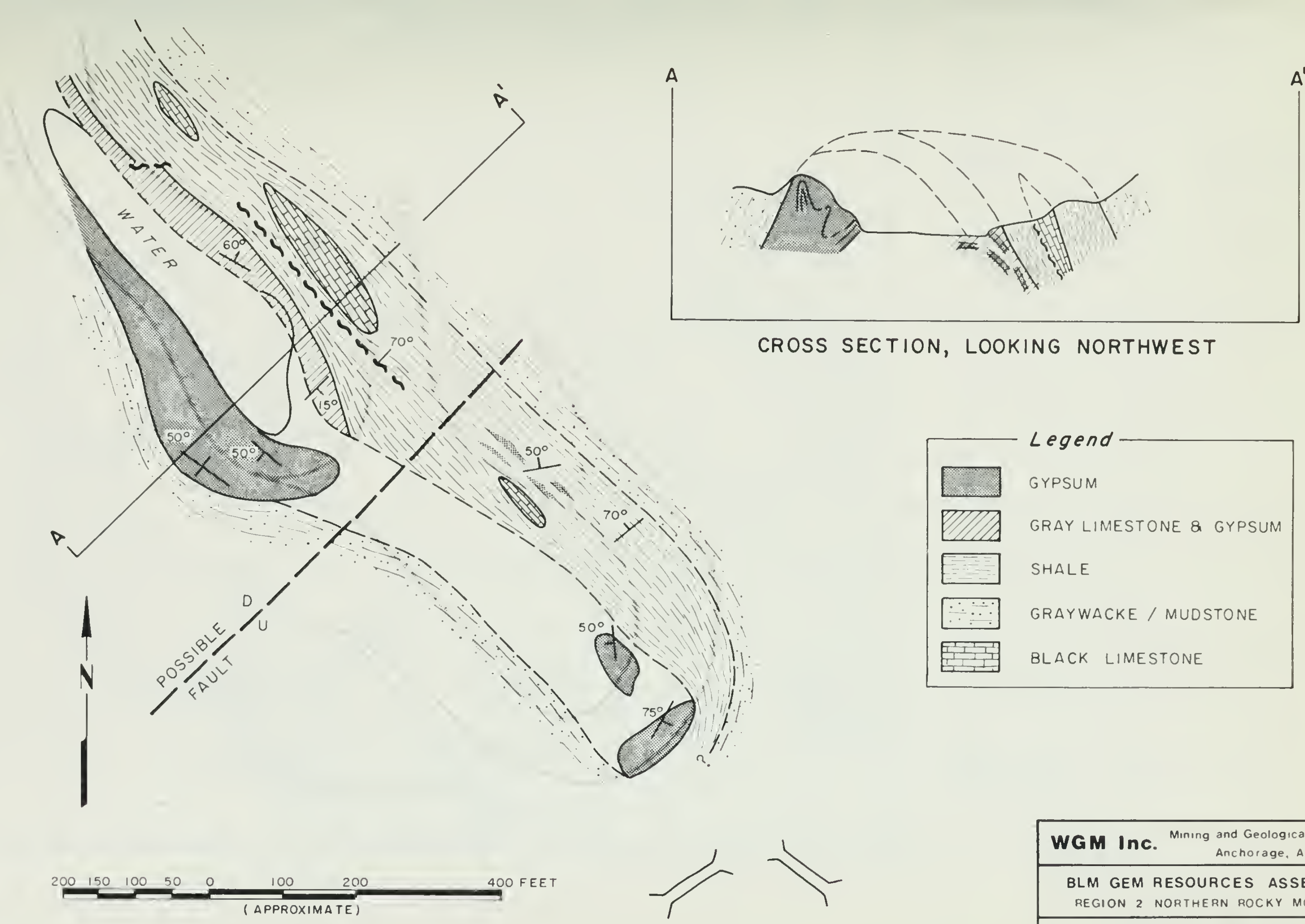
SCALE 1"=1 MILE (1:62,500)			FIGURE
DATA BY	DATE 3/1983	REV. SEC.	10
DRWN BY DSI	APPRVD G F		

11-19, Fig. 10), some of which have produced, but most of which are exploratory in nature.

During the site inspection by WGM personnel in the fall of 1982 there was evidence of recent underground exploration; including shaft sinking, and rotary drilling southwest of the Viola mine and north of Cedar Gulch along the crest of the range. The Paleozoic rocks underlying the Nicholia district have been extensively broken by moderately to steeply dipping faults, and intruded to a limited extent by granitic and rhyolite porphyry dikes. The orebodies, however, have no obvious connection to either of these features.

A small gypsum mine (loc. 2, Fig. 9, Table I) is located on Clear Creek in the northern part of the Eighteen Mile GRA. There are no production records for the mine, however it appears to have been active in the past 5 to 10 years. The only reference to this mine in the literature is a brief statement that the deposit was formed by hot springs activity along a fault zone (Withington, 1964). The mine was examined by WGM personnel in October 1982 as part of the GEM project. This examination plus other descriptions of gypsum deposits in southwestern Montana (Johns, 1980) suggest that the deposit may be stratabound rather than hydrothermal.

The deposit consists of one or more southeasterly-plunging lenses of massive to bedded gypsum (Fig. 11). The lenses are localized and tectonically thickened along the axis of a southeast-plunging anticline. The anticline may be a drag-fold related to a prominent northwest-trending fault which runs down the north side of Clear Creek Valley (Fig. 12). The gypsum is



DATA BY: G. FERNETTE, W. JONES, WGM INC. 1982.

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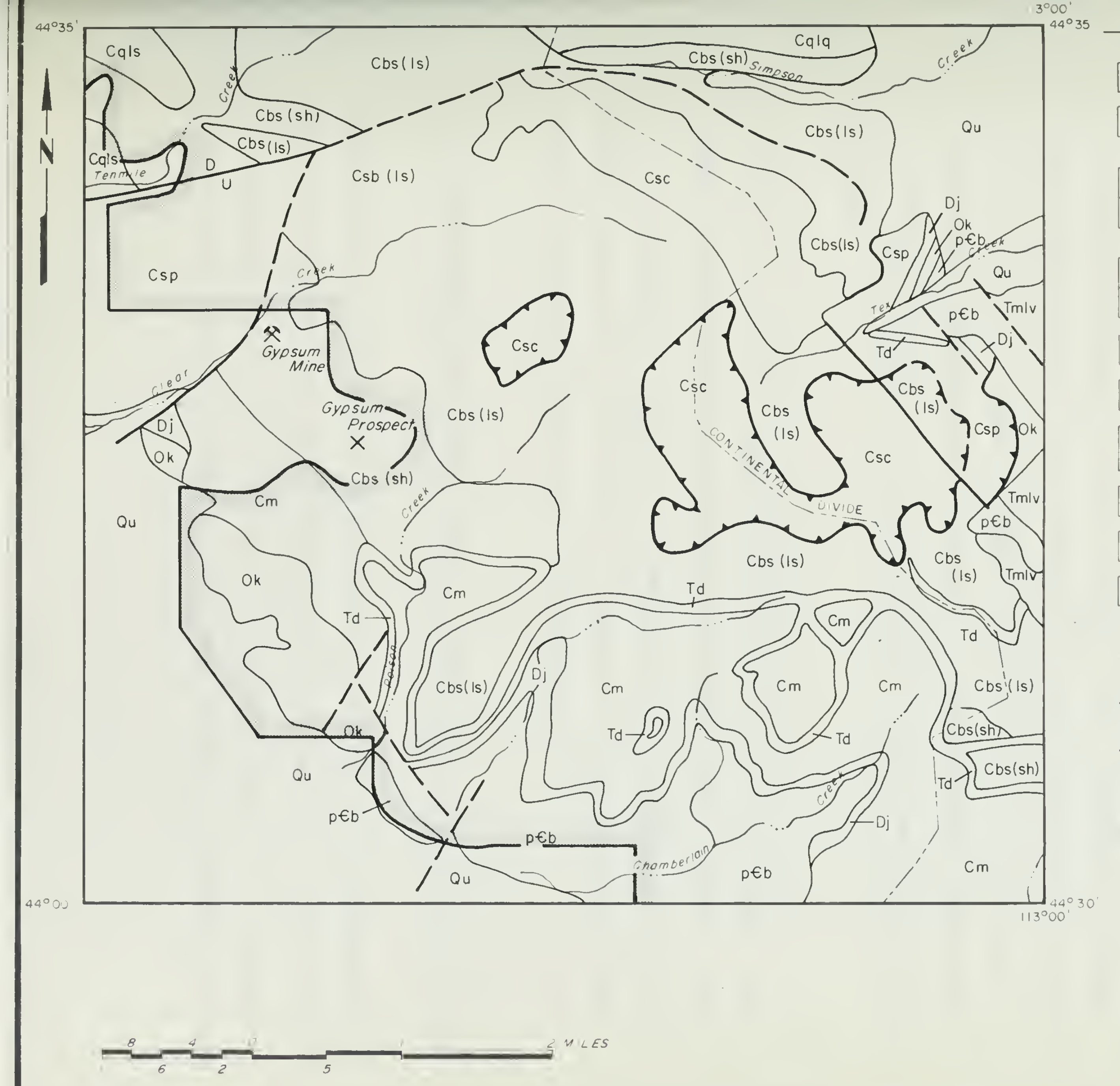
REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA, Montana-Idaho

Clear Creek Gypsum Mine Geologic Map

SCALE APPROX 1"=200'			FIGURE
DATA BY WGM	DATE 3/1983	REV SED	11
DRWN BY DSI	APRVD G F		



Data from: Schoten and Ramspott (1968).

Legend

Qu	Undifferentiated Quaternary Deposits
Tmlv	Medicine Lodge Volcanics
	Quadrant Formation
Cqls	—ls Limestone
Cqlq	—lq Quartzite
Td	Tertiary diabase
	Big Snow Group
$Cbs_{(ls)}$	(ls) Limestone
$Cbs_{(sh)}$	(sh) Shale
Ccs	South Creek and Surrett Canyon Limestones
Csp	Scott Peak Limestone
Cm	Milligan and Middle Canyon Sandstone and Shale
Dj	Jefferson Dolomite
Ok	Kinnikinic Quartzite
p€b	Belt Sandstone (Sawager Quartzite)
—	Contact
— — —	Fault, dashed where approximate
▲▲▲	Thrust fault
⌊	Boundary of WSA 43-3

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA, Idaho-Montana

Clear Creek Gypsum Area Geologic Map

SCALE 1"=1 MILE (1:62,500)			FIGURE
DATA BY	DATE 3/1983	REVISED	12
DRWN BY DSI	APRVD G F		

underlain and interbedded with gray, thin-bedded, fine-grained limestone and overlain by black to brown shale with lenses of black limestone. Thin gypsum beds also occur in the shale. The section is capped by gray-brown bedded to blocky, graywacke and mudstone. The host rocks are part of the Big Snowy Formation.

The gypsum has been mined by an open-pit developed on two levels. The lower pit is 450 feet long, 100 to 150 feet wide, and 50 feet deep. The upper level is about 500 feet long, 100 to 200 feet wide and has two 30 to 40 foot benches. The largest lense of gypsum is exposed on the south side of the lower level. The gypsum in the lenses is very pure (visual estimate more than 90% gypsum) whereas the gypsum interbeds in the limestone and shale are less pure.

The deposit is clearly stratabound and not related to hot springs. The deposit has been tectonically thickened along the nose of the fold. The Clear Creek deposit is similar in composition and structural setting to the deposits described by Johns (1980) in Beaverhead County, Montana. Those deposits are also hosted by the Big Snowy Formation.

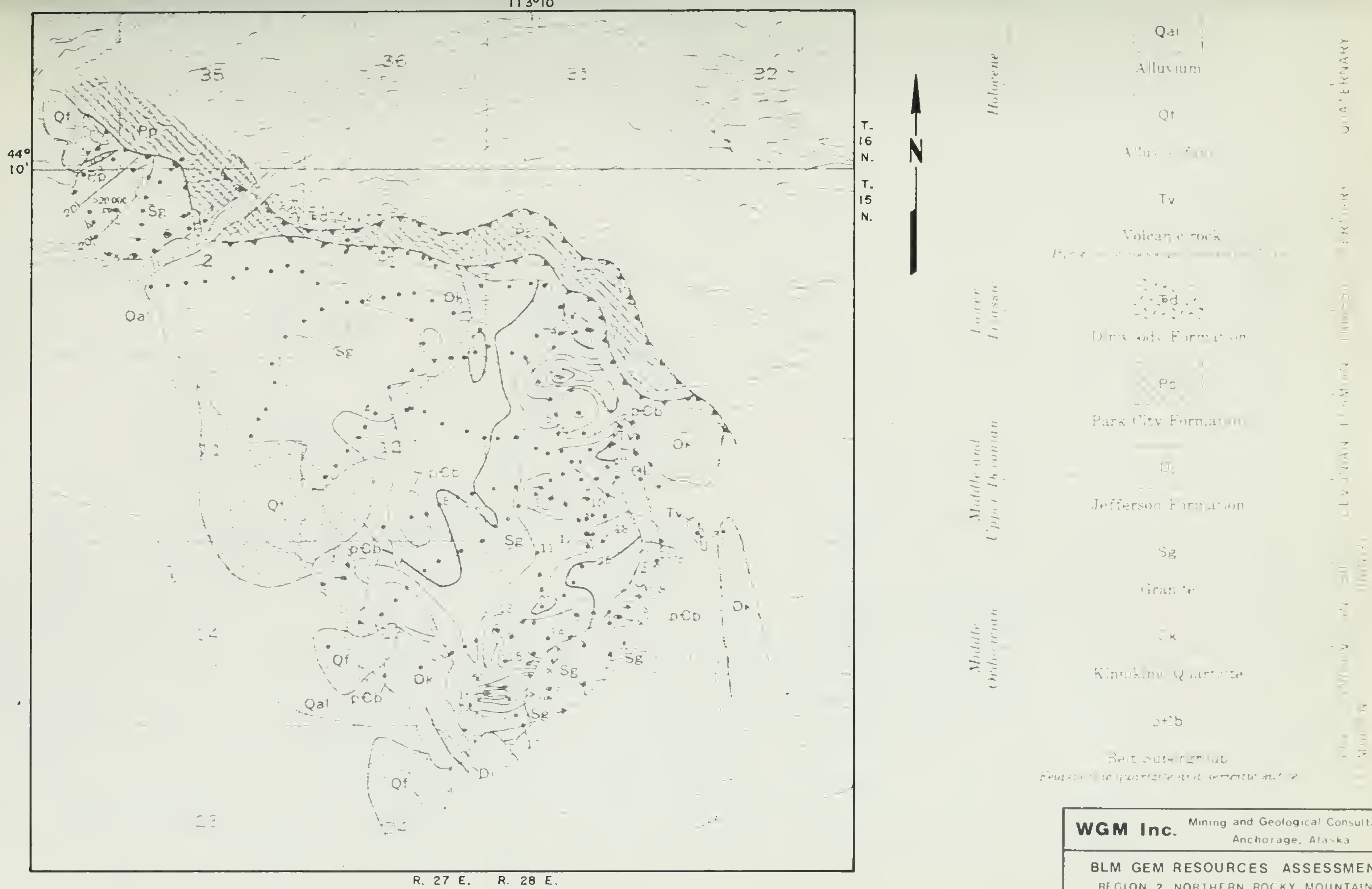
3.3 Known Mineral and Energy Prospects, Occurrences, and Mineralized Areas

There are four other mineral occurrences or prospects in the Eighteen Mile GRA in addition to those described above (Fig. 9, Table I). These include a second gypsum occurrence (loc. 4) and a silica prospect (loc. 3) located south of Clear Creek. Available descriptions of these prospects are limited

to MILS references. The other occurrences are the Kay claims (loc. 1) and an unnamed phosphate occurrence (loc. 5).

The Kay thorium prospect, located near the northern boundary of the Eighteen Mile GRA (Fig. 13), cover parts of an anomalously radioactive granitic intrusive located between Bull Creek and Hawley Creek (Staatz et al., 1972). The stock intrudes Ordovician Kinnikinic Quartzite and Precambrian rocks but is thrust over Permian rocks (Lucchitta, 1966). The granite is similar to other intrusives in the region dated as lower Paleozoic (Ruppel, 1968; Ramspott and Scholten, 1965). The stock is composed of medium-grained, tan, pink or white granite. The anomalous radioactivity is associated with zones of fracturing, red hematite staining, and alteration. The average thorium content of the granite is 35 ppm with local altered areas containing over 100 ppm. Most of the thorium occurs as fine crystals of thorite along fractures in perthite (Staatz et al., 1972). Staatz et al. (1972) conclude that the thorium originally occurred in zircon, allanite and monazite and was subsequently redistributed by hydrothermal alteration.

The phosphate prospect (loc. 5, Fig. 9, Table I) located along Dry Canyon just north of the boundary of WSA 43-3 (Fig. 14). This deposit, along with others to the north near Hawley Creek, is described by Oberlindacher and Hovland (1970). The phosphate occurs as oolites, pellets, and nodules in the Retort Member of the Phosphoria Formation. The Retort Member averages 70 feet thick in this area. Oberlindacher and Hovland (1979) estimate the phosphate resources in the Dry Canyon area at a minimum of 70.16 million short tons of low grade (16 to 25%) and 18.25 million short tons of medium grade (24 to 31%) phosphate rock.



Site of radiometric reading

Radiometric isograds

Data from: Staatz et. al. (1972)

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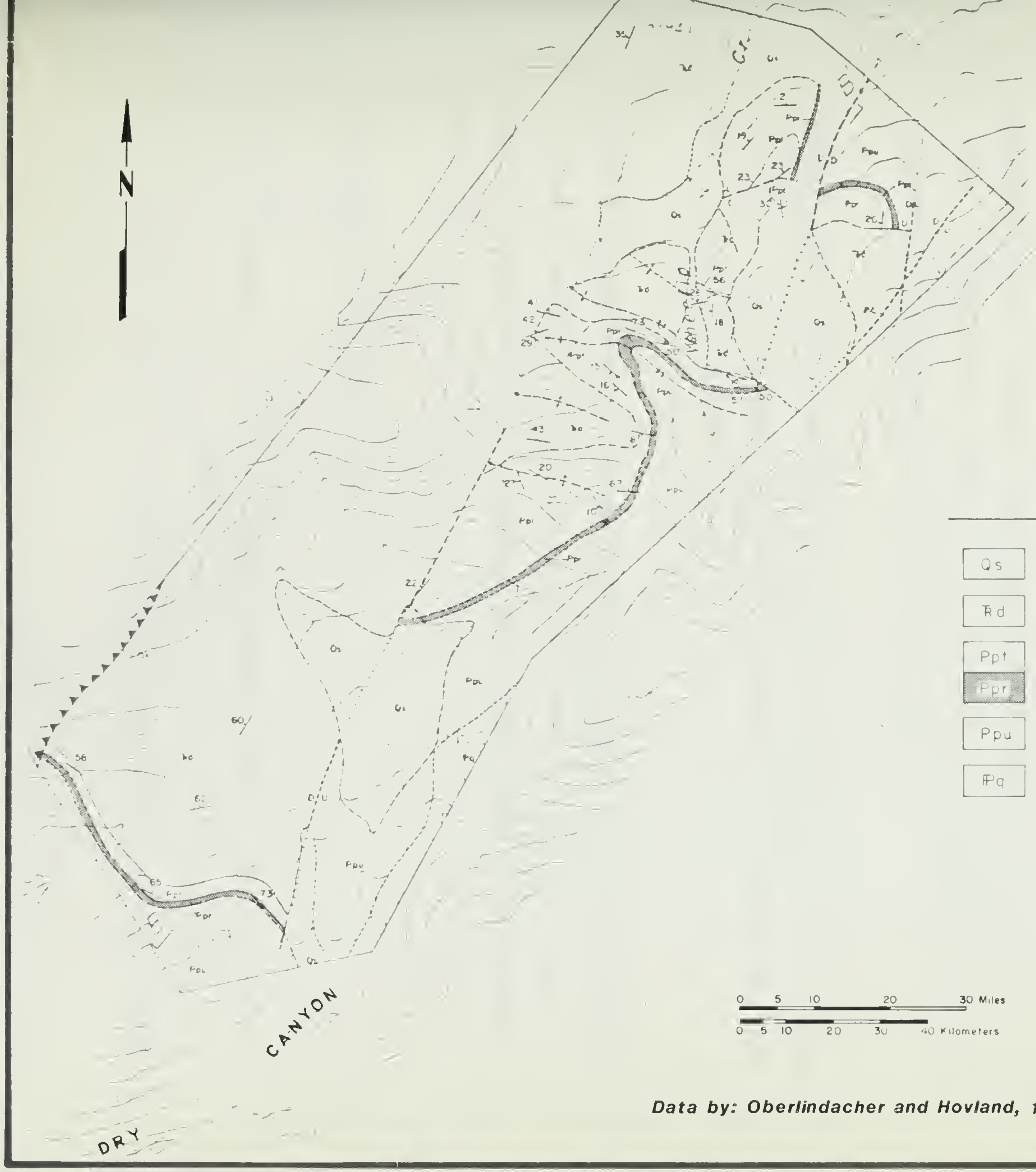
REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteenmile GRA,
Idaho-Montana
Geology of the Kay Thorium Prospect

AS SHOWN			13
DATA BY	DATE 3/1983		
DRAWN BY DSI			



Data by: Oberlindacher and Hovland, 1979

EXPLANATION

Qs	Surficial deposits
Rd	Dinwoody Formation
Ppt Ppr ▨	Phosphoria Formation Ppt, Tosi Chert Member Ppr, Retort Phosphatic Shale Member
Ppu	Park City Formation
Pq	Quadrant Formation

CONTACT
FAULT
THRUST FAULT
ANTICLINE
OVERTURNED ANTICLINE
SYNCLINE
OVERTURNED SYNCLINE
⚒ PHOSPHATE PROSPECT PIT

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Eighteenmile GRA,
Idaho-Montana

Dry Canyon Phosphate Deposit

SCALE AS SHOWN			**14**
DATA BY	DATE 3/1983		
DRWN BY DSI	APPR. GF		

Beds of bituminous coal occur in the Tertiary Medicine Lodge beds in Montana 15 miles northeast of the Eighteen Mile GRA (Dyni and Schell, 1982). None of these are within the GRA.

3.4 Mining Claims, Leases and Material Sites

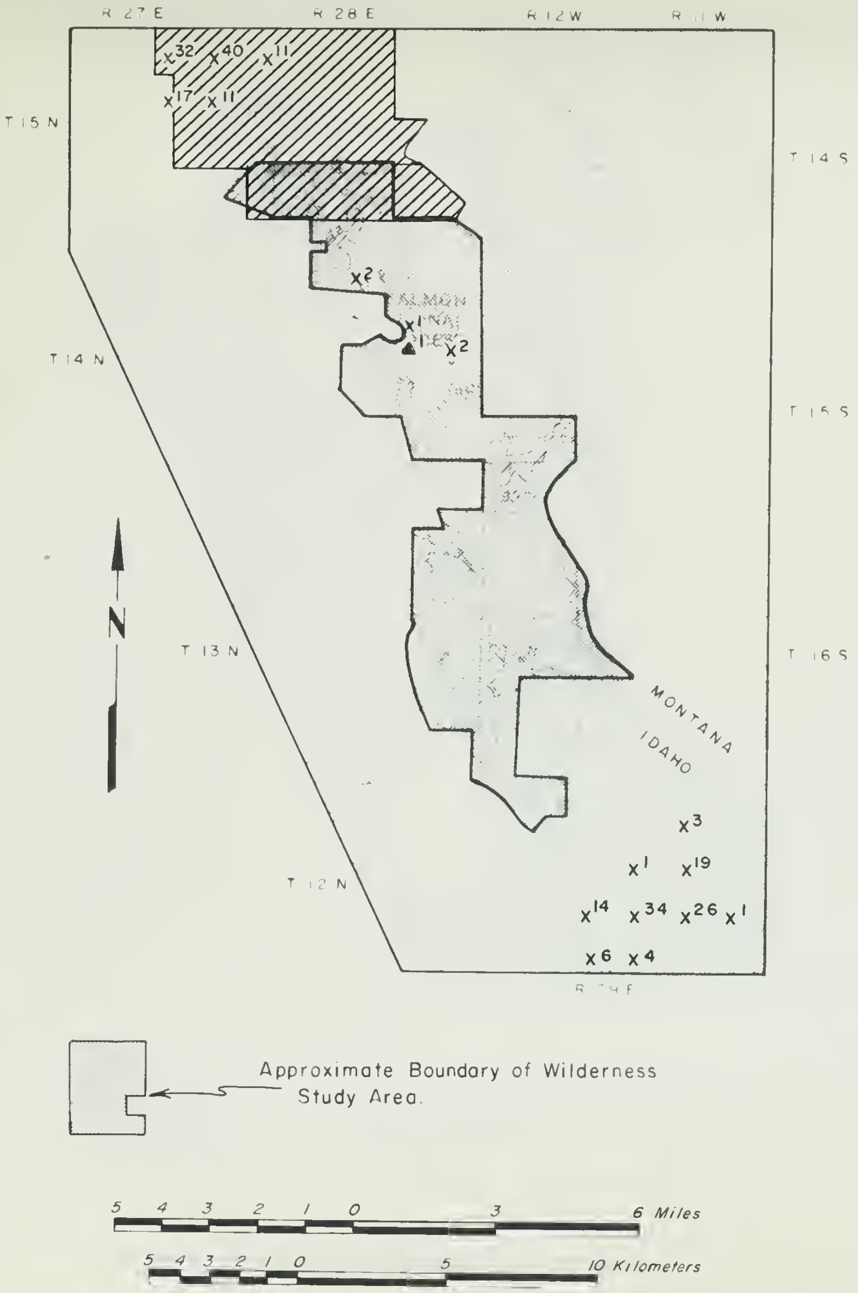
A review of BLM claims records current to June 7, 1982 shows that there are 221 unpatented mining claims and one patented claim in the Eighteen MIle GRA (Fig. 15). The majority of the claims are in two areas: (1) the Kay thorium prospect area (111 claims), and (2) the Nicholia district (108 claims). There are two unpatented claims covering the Gypsum mine on Clear Creek and one patented claim south of Clear Creek.

Approximately 70% of the Eighteen Mile GRA is covered by oil and gas leases (Fig. 16). Thirteen leases overlap the Eighteen Mile WSA (Table II). About 60% of the WSA is covered by leases.

About 20 square miles of the northwestern part of the Eighteen Mile GRA is covered by phosphate prospecting permit applications (Fig. 15). These applications include the northernmost three square miles of the Eighteen Mile WSA.

3.5 Mineral and Energy Deposit Types

The best potential for metallic mineral deposits in the Eighteen Mile GRA is for lead-zinc-silver deposits. Lead-zinc-silver orebodies have been mined at a number of localities in Idaho including the Bayhorse (McIntyre et al.,



EXPLANATION

x Unpatented Mining Claim

▲ Patented Mining Claim

▨ Phosphate Prospecting Permit Application.

Notes: 1) Number adjacent to symbol indicates number of mining claims in that section.

2) Area of search: Entire GRA

3) Source of Data: BLM Claims Files and LSBL Min. Plats.

4) Data current to: August 30, 1982 (Mont.)
June 7, 1982 (Id.)

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REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA,
Idaho-Montana

Mining Claims and Mineral Leases

SCALE 1"= 4 MILES			FIGURE
DATA BY	DATE 1/1983	REVISED	15
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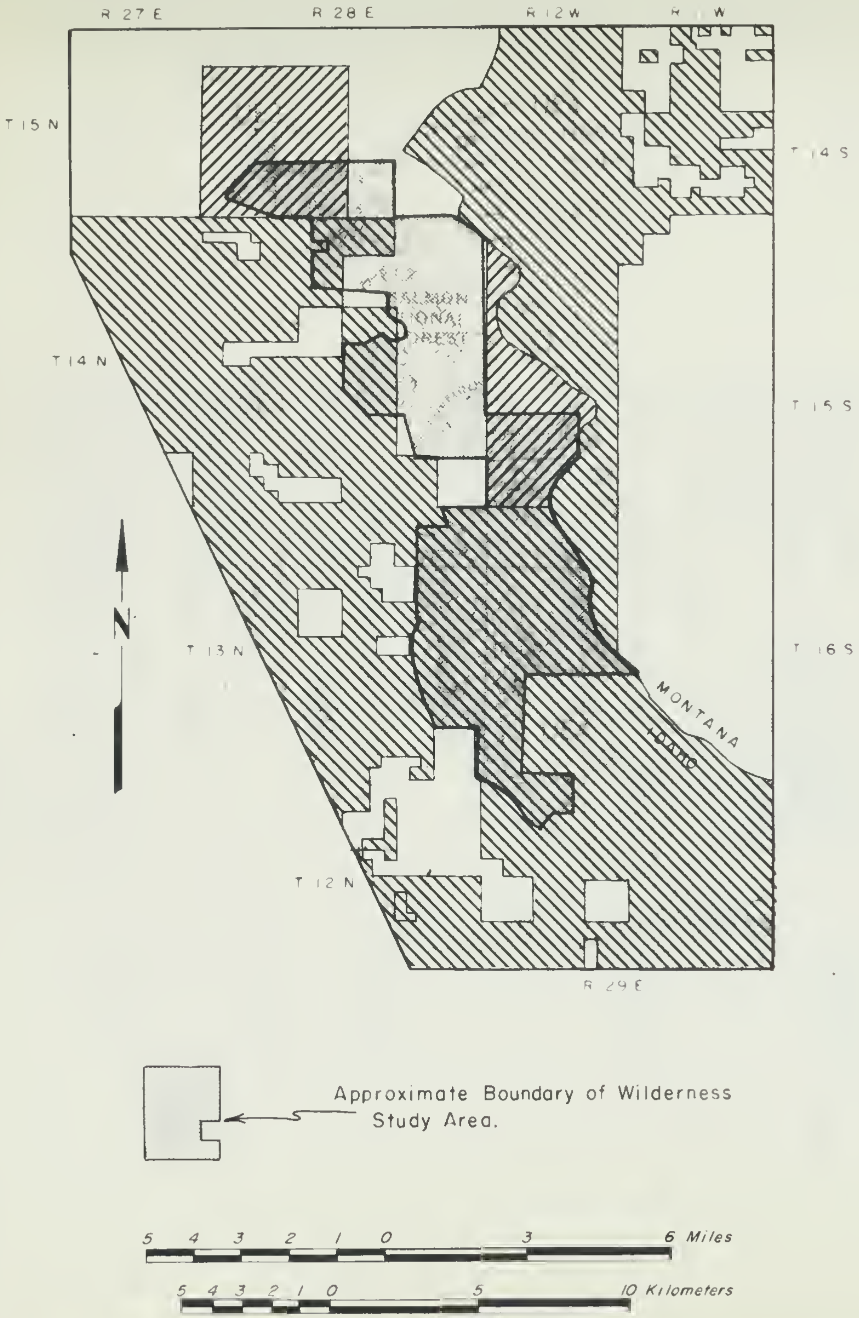

LEGEND

▧ Area covered by oil and gas leases.

▨ Area covered by oil and gas lease application.

Notes: 1) Area of Search: Entire GRA except T. 15 N, R. 27 E.
2) Data current to: August 12, 1982.
3) Source of Data: BLM O.G. Plats

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REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA,
Idaho-Montana

Oil and Gas Lease Status

SCALE 1"=4 MILES
DATA BY WGM DATE 1/1983
DRAWN BY DSI APP'D GF

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TABLE II

OIL AND GAS LEASES IN THE EIGHTEEN MILE WSA

Lease No.	Owner of Record	Date Issued
I 16529	First Mississippi Corp. P.O. Box 1249 Jackson, Mississippi 39205	08-01-80 (Applic. Filed)
I 16605	Pioneer Production Corp. P.O. Box 2542 Amerillo, Texas 79189	08-01-81
I 16668	Joseph Albright 1629 K St. N.W. Suite 520 Washington, D.C. 20006	01-01-81
I 17026	S. Dawson P.O. Box 585 Salt Lake City, Utah 84110	01-01-82
I 17027	S. Dawson P.O. Box 585 Salt Lake City, Utah 84110	04-01-82
I 17164	Robert Balsam - 1/8 interest John Warne - 3/8 interest Irvin Kranzler - 3/8 interest Carl Field - 1/8 interest Box 1324 Billings, Montana 59103	12-16-80 (Applic. Filed)
I 11340	Mobil Oil Corporation - 50% P.O. Box 5444 Denver, Colorado 80217 Amoco Production Co. - 50% Amoco Bldg. 17th & Broadway Denver, Colorado 80202	11-01-77
I 11367	Mobil Oil Corporation P.O. Box 5444 Denver, Colorado 80217	11-01-77
I 11379	Mobil Oil Corporation P.O. Box 5444 Denver, Colorado 80217	11-01-77
I 11388	Mobil Oil Corporation P.O. Box 5444 Denver, Colorado 80217	11-01-77

TABLE II (Cont.)

OIL AND GAS LEASES IN THE EIGHTEEN MILE WSA

Lease No.	Owner of Record	Date Issued
I 11389	Mobil Oil Corporation P.O. Box 5444 Denver, Colorado 80217	11-01-77
I 11392	Mobil Oil Corporation P.O. Box 5444 Denver, Colorado 80217	11-01-77
I 11393	Mobil Oil Corporation P.O. Box 5444 Denver, Colorado 80217	11-01-77

1976; Ross, 1937), Junction (Ruppel, 1978), Gilmore (Ruppel et al., 1970; Ruppel and Lopez, 1981), Blue Jay (Ruppel et al., 1970), Lava Creek (Anderson, 1929; Ross, 1931), Little Wood River (Nelson and Ross, 1962, Dover et al., 1981), Copper Basin (Dover et al., 1981) and Eureka (Anderson, 1956) districts. The mineralization in these districts consists of irregular veins and replacement bodies in folded and faulted sedimentary and metamorphic rocks and to a lesser extent in intrusive rocks. Quartzite, argillite, limestone and dolomite are common host rock lithologies, however limestone and dolomite are the most abundant hosts (Hobbs, 1968). Argentiferous galena, sphalerite and freibergite with lesser amounts of pyrite and chalcopyrite are the principal metallic sulfide minerals (Kiilsgaard, 1964). The deposits are commonly oxidized at the surface and much of the early production was of secondary silver-lead-zinc ores. At Gilmore, about 6 miles west of the Eighteen Mile GRA, lead-silver orebodies occur in fracture zones parallel in strike but opposite in dip to the dolomite host rock. Vein mineralization consists of quartz and simple sulfides (Ross, 1941). The host dolomite belongs to the lower Jefferson Dolomite (Ruppel and Lopez, 1981). The principal deposits appear to be associated with a Tertiary stock intruded along the flank of an uplifted mountain block (Ruppel, 1982). These igneous-associated deposits were formed in the late stages of the Laramide orogeny.

The mineralization in the Nicholia and Birch Creek districts is similar to that of the intrusive associated deposits described above except that Teritary stocks or sheets are absent in these areas. The mineralization forms irregular replacement bodies along fault zones in Paleozoic limestone. The Nicholia district, in the Eighteen Mile GRA, is located several

miles south of the Beaverhead pluton which is dated as Ordovician by Scholten and Ramspott (1968), and mapping of plutons to the north by Staatz et al. (1972), also indicates a lower Paleozoic age for plutons in the Beaverhead Range. Anderson and Wagner (1944) describe dikes and granite at the Viola mine in the Nicholia district but state that there is no apparent relationship between the mineralization and the intrusive. Scholten and Ramspott (1968) also conclude that the granitic rocks are not related to the mineralization. The Viola mine and many of the prospects in the district are aligned in a roughly east-west-trending zone which appears to be structurally controlled. No apparent relationship between the mineralization and the intrusives was observed by WGM geologists during their visit to the Viola mine.

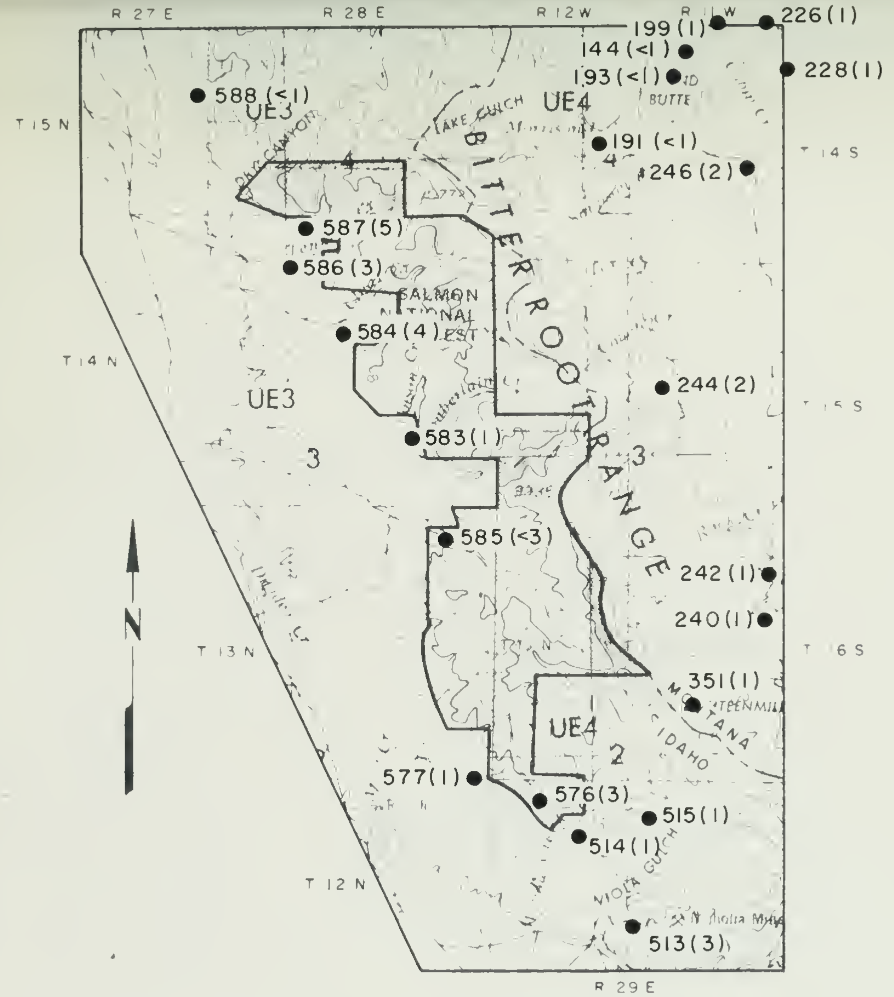
The Eighteen Mile GRA is situated in an older continental margin setting. One of the major metallic mineral deposit types expected in this setting is carbonate or sandstone-hosted lead-zinc deposits Mitchell and Garson (1981). The lead-zinc deposits in this setting are known as Mississippi Valley-type mineralization and are characterized by the following:

1. simple sulfide mineraogy
2. generally hosted by dolomites, less commonly by sandstones or limestones
3. absence of nearby intrusive rocks
4. mineralization related to local facies changes in host rock
5. districts related to basinal margins
6. relatively simple structure at time of description

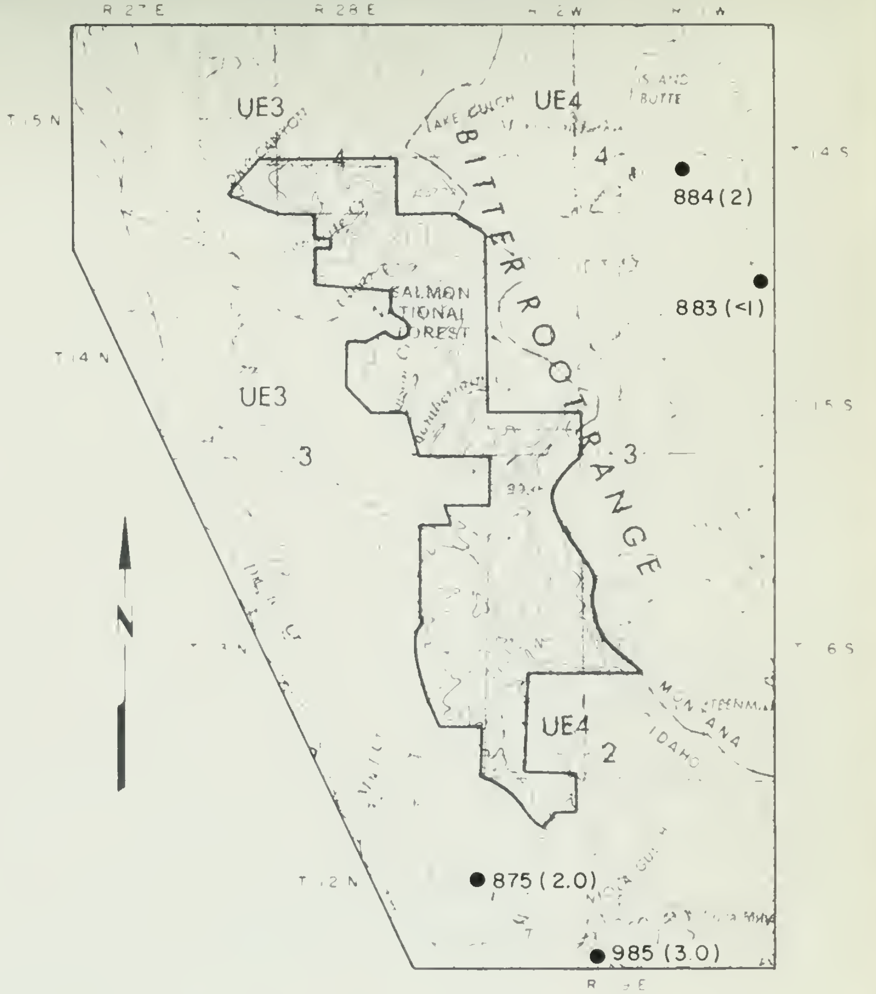
The Paleozoic ages of leads from the Wood River district (Hall et al., 1978), the general characteristics of some of the lead-zinc mineralization in east-central Idaho, and the presence of stratabound lead and copper mineralization in Cambrian rocks in southeastern Idaho (Mansfield, 1929) suggest potential for Mississippi Valley-type mineralization in the older continental margin setting of east-central Idaho.

Although the allochthonous nature of the terrane within the Eighteen Mile GRA obscures the facies relationships among the sediments, both breccias and reef complexes, which are excellent ore hosts elsewhere, may be present in the Paleozoic carbonates. If Mississippi Valley-type lead-zinc mineralization is present in east-central Idaho, then the known lead-zinc occurrences may represent remobilization undiscovered mineralization during later geologic processes (ground water migration along fractures and faults in the Nicholia district and igneous intrusion at Gilmore).

The uranium resource potential of the Dubois Quadrangle, which includes the Eighteen Mile GRA, was studied by Wodzicki and Krason (1981). A total of 49 geochemical samples were collected from the GRA (Table III, Figs. 17 and 18). Many of these were taken from streams draining the Eighteen Mile WSA. Threshold for cold extractable uranium in stream sediment ssmples (Fig. 19) is 20 ppm (Wodzicki and Krason, 1981). One stream sediment sample taken in the GRA is anomalous in uranium (Sample no. 519, Fig. 18), with a value of 29 ppm. The sample is near the Beaverhead Pluton. Interpretation of airborne and ground radiometric data shows a weak (2 to 3 times background) anomaly along the south side of the Beaverhead Pluton in the area drained by the anomalous stream (Wodzicki and Krason, 1981).

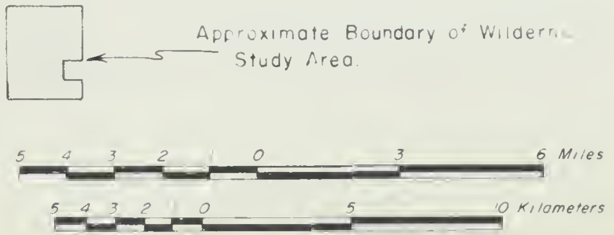


A. **Stream Water Samples**



B. Water-well and Spring Samples

Legend



Approximate Boundary of Wilderness Study Area.

Sample Location —— ● 875 (2.0)

Uranium Concentration in ppb

Sample Location

Data from: Wodziki and Krason (1981).

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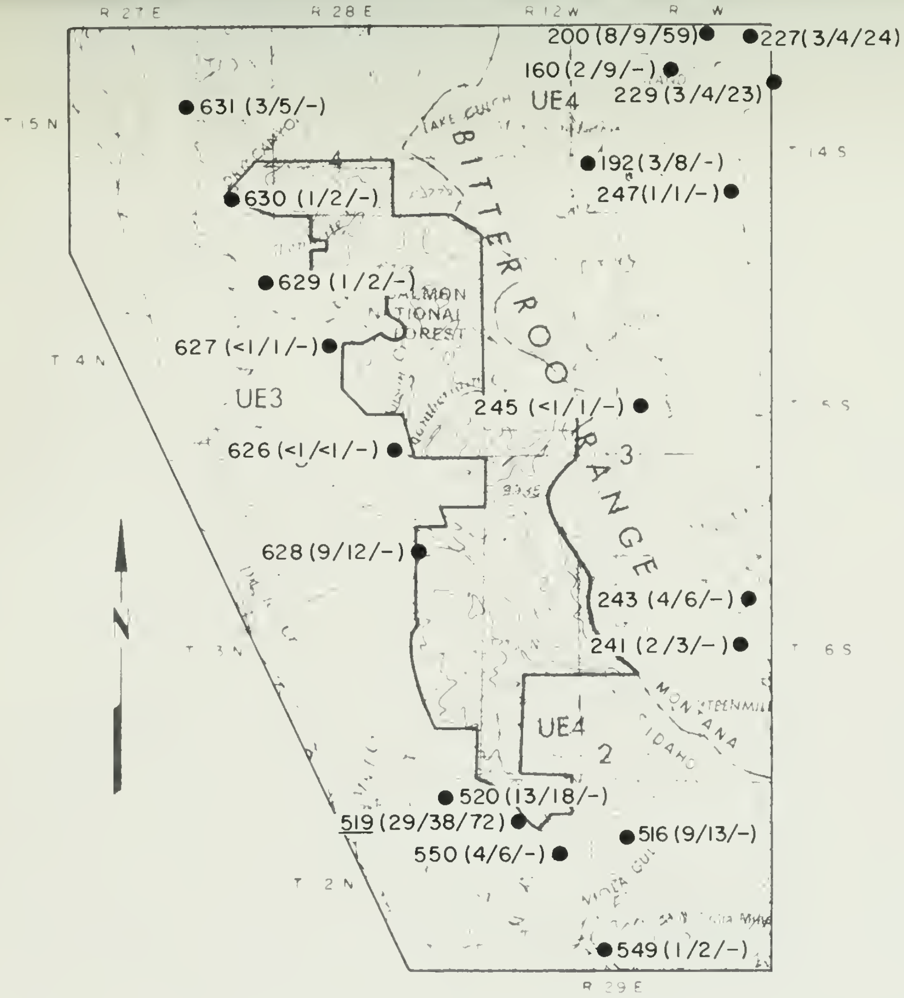
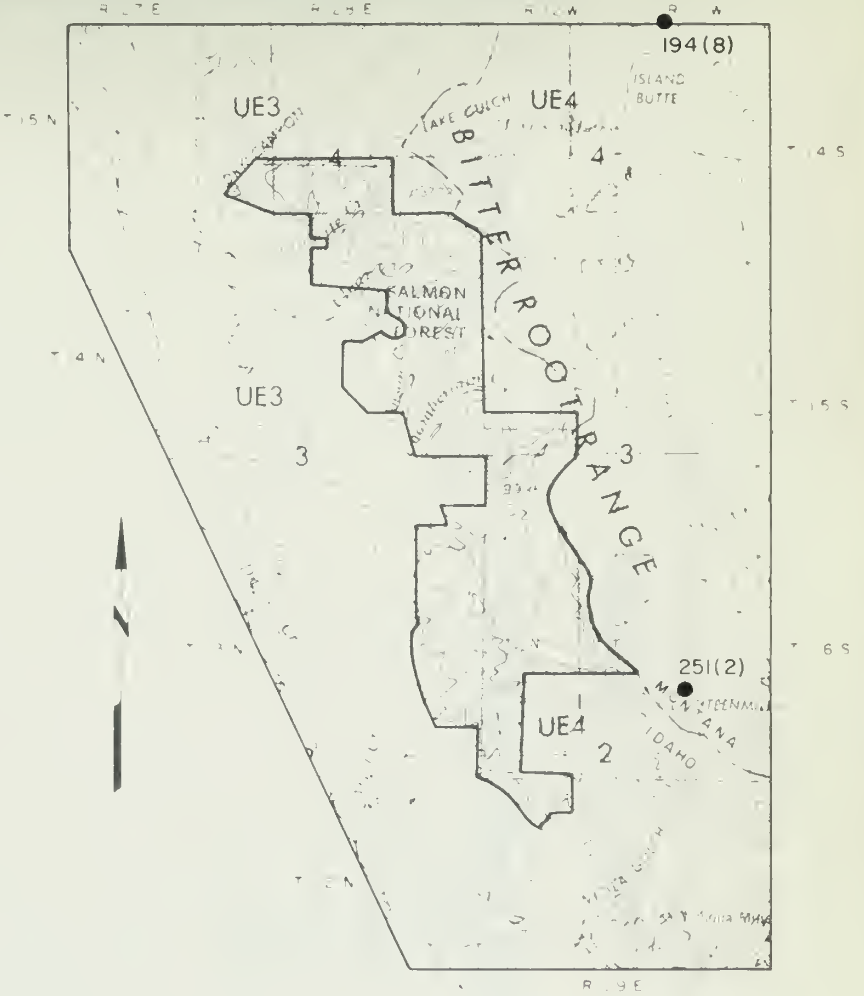
Eighteen Mile GRA,
Idaho-Montana

NURE Water-Sample Data

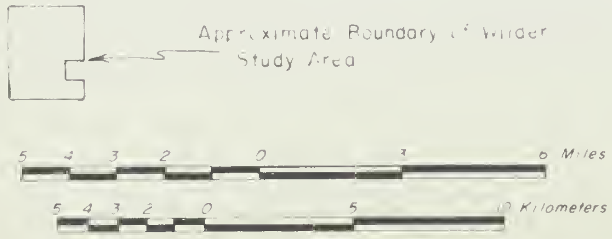
SCALE 1" = 4 MILES (1:250,000)		FIGURE
DATA BY	DATE 3/1983	17
DRAWN BY DSI	APPROVED GF	



A. Stream Sediment Samples



B. Rock Samples (Total Uranium)


Approximate Boundary of Wilder Study Area
5 4 3 2 0 3 6 Miles
5 4 3 2 0 5 10 Kilometers

Legend

Sample Location ● 549 (3/5/24)

- Sample Number (Under Lined if Anomalous)
- Cold Extractable Uranium ppm
- Total Thorium ppm
- Total Uranium (ppm)

Data from: Wodziki and Krason (1981).

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA,
Idaho-Montana
NURE Sample Data
Stream Sediments and Rocks

1"=4 MILES (1 250,000)
3, 1983

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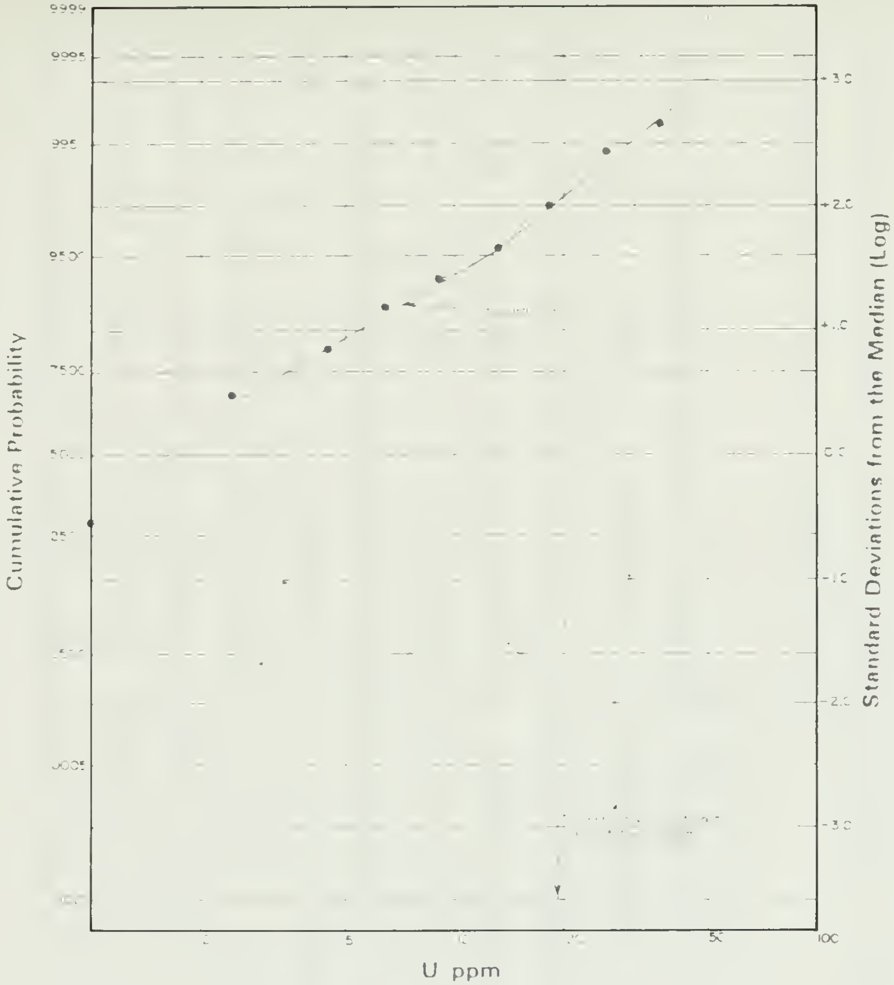
TABLE III

SUMMARY OF URANIUM GEOCHEMICAL SAMPLING, EIGHTEEN MILE GRA, IDAHO

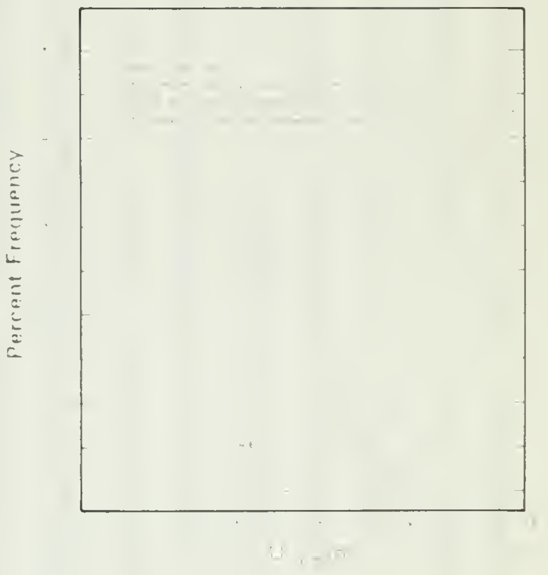
Sample Type	No. of Samples	Range U (ppm)	Anomalous Samples
Stream Sediment	20	1-29 ppm	1
Stream Water	22	1- 5 ppb	0
Waterwell and Springs	4	1- 3 ppb	0
Rock	2	2- 8 ppm	0

EXPLANATION



Cumulative probability plot of uranium concentration
in stream sediments.

Data from: Wodziki and Krason (1981).



Logarithmic histogram of total uranium
in stream sediments.

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REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteenmile GRA,
Idaho-Montana
Summary of NURE Stream Silt
Sampling Dubois Quadrangle

3 1983

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Wozicki and Krason (1981) identified two favorable geologic environments in the Dubois Quadrangle for uranium deposits. These are in: (1) the Mississippian McGowan Creek Formation in the Birch Creek-Heart Mountain area, south of the Eighteen Mile GRA, and (2) in Tertiary sedimentary basins. In the McGowan Creek Formation uranium occurs in autinite along with quartz and limonite in shear zones. The uraniferous zones are restricted to siltstone lenses in mudstone and black chert. The Birch Creek-Heart Mountain area has no geochemical expression but is delineated by the radiometric data. The McGowan Creek Formation is present in the Eighteen Mile GRA and crops out within the WSA. There are no radiometric anomalies in these areas but the data and sampling are reconnaissance in nature. Wodzicki and Krason (1981) recommend a detailed study of the McGowan Creek Formation in the entire Dubois Quadrangle. There are no Tertiary basins within the Eighteen Mile GRA.

The Lemhi Pass thorium district, the largest thorium district in the United States (Staatz, 1979), is located north of the Eighteen Mile GRA. In the Lemhi Pass district, numerous thorium veins and minor copper, quartz and iron veins are located along the continental divide in the Beaverhead Mountains. The district, about 13.5 miles long and 12 miles wide, is part of a larger north-northwest-trending thorium-rich belt at least 85 miles long. This belt extends from southern Ravilli County, Montana to the vicinity of Bull Canyon, 10 miles southeast of Leadore, Idaho. Practically all the veins in the belt are hosted by Precambrian sedimentary rocks. Staatz (1979) estimates the inferred and indicated resources of the district to be over 300,000 tons of thorium oxide and over 300,000 tons of rare earth oxides.

Over two hundred veins are known to occur in the Lemhi Pass district and others may be unrecognized because of the recessive weathering nature of the veins. These veins range in length from a few feet to almost a mile and commonly exceed 1,000 feet along strike. Thickness ranges from thin veinlets up to 40 feet, with most exceeding one foot. Evidence from surface exposures indicate that the thorium veins persist at depth since they are found at elevations ranging from 5,200 feet to 9,400 feet. One vein can be traced over an elevation difference of 520 feet. Most of the thorium veins strike between N40°W and N80°W and dip steeply to the south. This orientation primarily reflects control by Tertiary faulting which persisted through the period of vein formation and resulted in post-mineralization brecciation and displacement along the veins. Groups of veins commonly occur in zones up to 50 feet wide (Staatz, 1979).

The basic mineralogy of the veins consists primarily of quartz and microcline gangue cut by numerous irregular limonite and hematite veinlets and masses containing thorite and other accessory minerals, including barite, and calcite. Thorite is found associated with the limonite minerals mostly in very small crystals 0.04 mm in diameter. Pyrite is commonly found in amounts of less than one percent, but much of the limonite is probably pseudomorphic after pyrite. Black amorphous manganese oxide minerals are also fairly abundant and may be intergrown with iron oxide minerals. The hematite present in the veins occurs either as black platy specularite or dark red granular hematite (Staatz, 1979).

The Kay thorium occurrence (loc. 1, Fig. 9), at the northern end of the Eighteen Mile GRA, is in lower Paleozoic plutonic rocks (Staatz et al.,

1972; Lucchitta, 1966) which are probably part of the Beaverhead Pluton (Scholten and Ramspott, 1968). Staatz et al. (1972) conclude that the thorium at the at the Kay prospect was formed as a result of post-magmatic hydrothermal activity and differs from the veins in the Lemhi Pass district in their age (Paleozoic rather than Tertiary) and in their host rock type (plutonic rather than sedimentary).

The gypsum deposit at Clear Creek is in the Mississippian Big Snowy Formation which hosts similar deposits occur in Montana (Johns, 1980); thus, any area underlain by the Big Snowy Formation has potential for similar deposits. Folding and faulting have acted to thicken and recrystallize both the Clear Creek and Montana deposits; therefore, strongly deformed areas underlain by the Big Snowy Formation would be most favorable for these deposits.

Portions of the Eighteen Mile GRA which are underlain by carbonate rocks may have potential for high calcium limestone and high mangesium dolomite (Savage, 1969). No data useful for evaluating this potential is available in the region encompassing the GRA.

The Eighteen Mile GRA is a part of the Cordilleran fold-thrust belt. Major hydrocarbon reserves are present some 200 miles southeast of the GRA in western Wyoming where three giant oil fields (Lamb, 1980; McCaslin, 1981) and 12 other fields are currently being developed. Some of the latter may be classed in the giant ranks when fully developed. Production within this area is from several horizons including Ordovician, Devonian, Mississippian, Pennsylvanian, Triassic, and Jurassic units (McCaslin, 1980, 1981). In the

Eighteen Mile GRA some of these Paleozoic units have equivalents, but Triassic rocks are thin and Jurassic rocks are absent. The nearest test well to the GRA was drilled by Amoco to 6,700 feet in sec. 16, T.12N., R.28E., several miles outside the GRA (Breckenridge, 1982). Amoco drilled another well, the New Milford #1, to 9,200 feet in sec. 19, T.15N., R.27E. (George Babits pers. comm., 1983). This well is 10 to 15 miles northwest of the Eighteen Mile WSA. No information is available on either well other than they were plugged and abandoned. According to Breckenridge (1982) numerous dry holes have been drilled in southeastern Idaho 80 to 200 miles southeast of the Eighteen Mile GRA. Several tests have also been drilled in western Montana, 15 miles southeast to 250 miles north of the Eighteen Mile GRA (McCaslin, 1981). Hydrocarbon shows have been reported in some of the above tests. Except for the absence of a relatively thick Mesozoic section and a thinner Paleozoic section the Eighteen Mile GRA is similar stratigraphically and structurally to southwestern Montana. General evaluations of the hydrocarbon potential of southwestern Montana have been made by Scholten (1967), Perry et al. (1981) and Peterson (1981). Scholten (1967) considers the area to have a low potential whereas both Peterson (1981) and Perry et al. (1981) consider the area to have some potential but conclude that further study is necessary.

Potential hydrocarbon source beds in the Eighteen Mile GRA are the dark shales of the McGowan Creek Formation, argillaceous limestones and calcareous shales of the Jefferson Formation, dark clayey-silty limestones of the South Creek Formation, and high organic beds in the Phosphoria Formation. All of these units except the South Creek Formation have had hydrocarbon analyses made on them from localities in east-central Idaho or

southwestern Montana. A petroleum company had samples of the McGowan Creek Formation from the White Knob and Lost River Ranges west of the Eighteen Mile GRA analyzed. The results of these analyses indicate that the unit has a mature, very poor oil, good to excellent wet-gas condensate source character (Nance Petroleum pers. comm., 1982). The organic carbon content of well-cuttings from the Three Forks Formation in southwestern Montana is 7.5% (Perry et al., 1981). This clearly implies that the Three Forks could be a hydrocarbon source bed where similar lithologies are present in the Eighteen Mile GRA.

Thermal maturity of source beds within the Eighteen Mile GRA has not been studied. However, the data known to the west (Nance Petroleum pers. comm., 1981) and the conodont color alteration indices reported for Mississippian strata in southwestern Montana (Perry et al., 1981) indicate that the thermal maturity has been of sufficient magnitude within the region to generate hydrocarbons.

Potential hydrocarbon reservoir beds in the Eighteen Mile GRA include surcosic dolostones in Ordovician and Devonian strata, and sandstones and conglomerates within the late Paleozoic strata. Fracture porosity may also occur in these units. The thrust faults and block uplifts of the region should provide structural traps for the reservoir beds. The numerous disconformities present in the lower Paleozoic section might also provide structural traps for the reservoir beds.

The southern half of the Eighteen Mile WSA is underlain by igneous rocks. These rocks are not hydrocarbon source beds and unless fractured and buried

beneath sedimentary rocks are not reservoir beds. Potential only exists for hydrocarbon resources in the southern half of the WSA if the igneous rocks at the surface are a part of the Beaverhead allochthon as suggested by Skipp and Hait (1977). In this case the intrusive would be thrust over Paleozoic or younger strata that could serve as reservoir beds.

There are no hot springs or other geothermal manifestations in the Eighteen Mile GRA, consequently the geothermal potential of the area must be evaluated by analogy based on the regional setting. The Eighteen Mile GRA is within the Central Idaho Basin and Range geothermal province which occupies the area between the Idaho batholith on the west, the Montana Basin and Range province on the east, and the Snake River Plains on the south. The area is distinguished from the Montana Basin and Range in that the bedrock of the province is predominately Precambrian and Paleozoic sedimentary rocks which have been extensively thrust faulted. The Eocene Challis Volcanics are the youngest volcanic rocks exposed in this province. Normal faulting appears to have been active until very recent times. In addition, a seismic trend extending westward from Yellowstone National Park passes through the center of the province. Another zone of seismic activity is present just west of the Central Idaho basin and Range geothermal province and an east-west trend of seismic activity is also present along the Centennial Mountains on the Montana border just east of the province (Smith, 1978). The hot spring frequency in the Central Idaho Basin and Range geothermal province is somewhat lower than in the Montana and Basin Range province; however, the Central Idaho Basin and Range province is virtually unknown on even a reconnaissance geothermal or geophysical basis. Typical heat flow values are probably the same as the Montana Basin and

Range province, but very little data is available. Due to the abundance of carbonate rocks in the province, the hydrology is probably more complicated than in the Montana Basin and Range province where less permeable granitic and metamorphic rocks predominate. However, it is not possible to predict the influence that bedrock hydrology might have on the location of geothermal systems in the Central Idaho Basin and Range province using existing data.

Apparently the Eighteen Mile region is not seismically active at present, but it lies between the east-west trending Centennial earthquake zone and an area of seismic activity in central Idaho between Challis and Stanley (Smith, 1978). Also, the physiographic expression of the ranges in the Eighteen Mile area is youthful. The nearest geothermal data to the area is on the east side of the Lemhi Valley at Wittaker and Big Eightmile Creek warm springs, 10 and 16 miles respectively from the WSA (Mitchell et al., 1980). Wittaker warm spring has a flow of 3,406 liters per minute at a temperature of 24°C, at least 15°C above the mean annual temperature. The flow of Big Eightmile Creek warm spring is not known, but the surface temperature is 33°C. Unpublished gradients from a 1,400 foot deep mineral exploration test in the Lemhi Valley directly east of the Eighteen Mile WSA are 85°C/km (4.7°F/100 ft.) and the bottom hole temperature is 37°C. Heat flow values and gradients in the Lemhi Range east of the WSA are 60 milliwatts per square meter and 25°C/km (1.4°F/100 ft.) slightly below normal for the province (Brott et al., 1976). Sharkey hot springs located along the west side of the Bitterroot Range about 40 miles north of the WSA, has a surface temperature of 52°C, a flow of 757 liters per minute, and an estimated reservoir temperature of up to 104°C (Mitchell et al., 1980). The

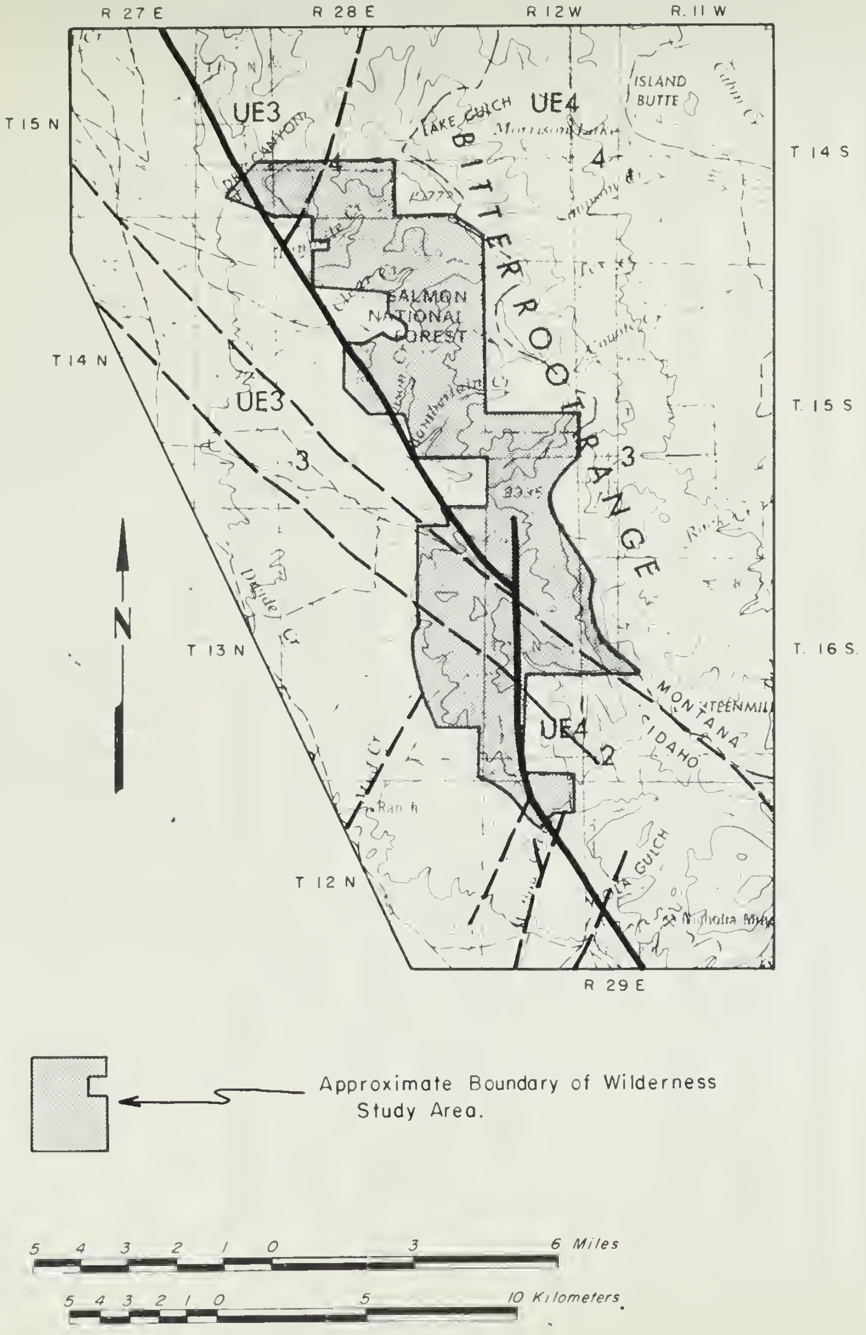
two warm springs issue from alluvial deposits, possibly overlying major fault structures, since the hot springs in this region are generally near the range-valley contact. This suggests control by the major range-bounding faults.

The probable hydrologic setting of the Beaverhead Range as a recharge zone and a comparison to the Lemhi Pass region and to the adjacent Lemhi Range suggest that relatively low gradients will be typical of the Beaverhead Range. However, comparison with other Basin and Range situations along with the presence of warm springs and high heat gradients along the eastern border of the Lemhi Range suggests that low temperature systems associated with major fault structures may exist, particularly at the intersection of low elevations and range front faults along the west side of the Beaverhead Range. Such an area is located in the westernmost part of the Eighteen Mile WSA where the Eighteenmile Creek Valley intersects the projected location of a range-bounding fault (Fig. 20).

3.6 Mineral and Energy Economics

Although the region encompassing the Eighteen Mile GRA is sparsely populated, the existing transportation infrastructure is adequate; thus, given sufficient reserves, grade and reasonable metal and energy prices, development of any metallic mineral or hydrocarbon deposits should not be impeded.

The rise in the price of silver in the late 1970s spurred considerable exploration interest. U.S. market demand has steadily increased as more



Legend

▬▬ MAJOR HIGH ANGLE FAULT

— — — LINEAMENT

Data from: Ruppel (1982), Mitchell et.al. (1980), Day (1974), Haskett (1974).

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REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA,
Idaho-Montana
Lineament and Fault Map

SCALE 1" = 4 MILES (1 250,000)		REVISED	FIGURE 20
DATA BY	DATE 9/1982		
DRWN BY DSI	APRVD GF		

industrial uses for silver are found (Rosta, 1982). Silver deposits formerly considered to be low grade are now economically attractive at present prices. Additionally, recoverable silver values in base metal ores, e.g. lead or copper, now make a substantial contribution to mine profits.

Gypsum which has been mined in the Eighteen Mile GRA is used in two forms: calcined and uncalcined (Appleyard, 1975). About 70% of the gypsum produced in the United States is calcined and is used primarily to produce gypsum wall board (Pressler, 1981). About 70% of the uncalcined gypsum is used in Portland cement, and the remainder is used as a soil conditioner. Gypsum demand is tied to the construction industry which has been depressed in recent years (Lacke, 1982). The price of gypsum averaged $8.53/ton in 1981 (Pressler, 1981).

Thorium is used in nuclear reactors, refractories, mantles for incandescent lights, magnesium alloys as a hardener, welding rods, and electronics (Kirk, 1981). A mineral sands operation in Florida is the only thorium producer in the United States. The remainder of U.S. thorium needs are imported or supplied from government stockpiles.

With the increase in the price imported oil in the past decade, the deregulation of domestic natural gas prices, and increasing government emphasis on energy self sufficiency, exploration and development of domestic oil and gas resources has proceeded at an accelerated pace. Natural gas reserves discovered in the late 1950s and 1960s in the Montana Disturbed

belt were not developed because of a lack of market (Heany, 1961). However, under present conditions drilling is taking place with a goal of near-term production.

The economic feasibility of geothermal resource development is determined by its distance to market and its temperature. Long-distance transportation of lower temperature geothermal energy is not feasible whereas for electrical grade resources long transportation distances are feasible. Based on present requirements for the use of hot fluids in electrical generating techniques, geothermal systems with temperatures of less than 150°C do not have significant potential for electrical exploitation. However, geothermal resources with temperatures less than 150°C do have significant potential for low and intermediate temperature geothermal utilization for space heating, material processing, etc. if their minimum temperature exceeds 40°C. At the lower end of the spectum, as the energy content of the resource becomes less, or the drilling depth necessary for exploitation becomes greater, there is a very ill-defined cutoff. For example, shallow ground water temperatures on the order of 10-20°C can be used for heat pump applications, and in some cases these are considered geothermal resources. However, in this evaluation, a lower temperature than approximately 40°C is considered uneconomic as a geothermal resource.

4.0 LAND CLASSIFICATION FOR GEM RESOURCES POTENTIAL

4.1 Explanation of Classification Scheme

In the following section the land in the Eighteen Mile GRA is classified for geology, energy and mineral (GEM) resources potential. The classification scheme used is shown in Table IV. Use of this system is specified in the contract under which WGM prepared this report.

The evaluation of resource potential and integration into the BLM classification scheme has been done using a combination of simple subjective and complex subjective approaches (Singer and Mosier, 1981) to regional resources assessment. The simple subjective approach involves the evaluation of resources based on the experience and knowledge of the individuals conducting the evaluations. The complex subjective method involves use of rules, i.e. geologic inference, based on expert opinion concerning the nature and importance of geologic relationship associated with mineral and energy deposts (Singer and Mosier, 1981).

The GEM evaluation is the culmination of a series of tasks. The nature and order of the tasks was specified by the BLM, however they constitute the general approach by which most resource evaluations of this type are conducted. The sequence of work was: (1) data collection, (2) compilation, (3) evaluation, and (4) report preparation. Two days of field work were done in the Eighteen Mile GRA.

TABLE IV

BUREAU OF LAND MANAGEMENT GEM RESOURCES LAND CLASSIFICATION SYSTEM

CLASSIFICATION SCHEME

1. The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of mineral resources.
2. The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.
3. The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.
4. The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.

LEVELS OF CONFIDENCE

A. The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.

B. The available data provide indirect evidence to support or refute the possible existence of mineral resources.

C. The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.

D. The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

Each WSA is classified for locatable, leasable, and saleable resources potential.

Locatable minerals are those which are locatable under the General Mining Law of 1872, as amended, and the Placer Act of 1870, as amended. Minerals which are lcoatable under these acts include metals, ores of metals, non-metallic minerals such as asbestos, barite, zeolites, graphite, uncommon varieties of sand, gravel, building stone, limestone, dolomite, pumice, pumicite, clay magnesite, silica sand, etc. (Maley, 1983).

Leasable resources include those which may be acquired under the Mineral Leasing Act of 1920 as amended by the Acts of 1927, 1953, 1970, and 1976. Materials covered under this Act include: asphalt, bitumen, borates of sodium and potassium, carbonates of sodium and potassium, coal, natural gas, nitrates of sodium and potassium, oil, oil shale, phosphate, silicates of sodium and potassium, sulfates of sodium and potassium, geothermal resources, etc. (Maley, 1983).

Saleable resources include those which may be acquired under the materials Act of 1947 as amended by the Acts of 1955 and 1962. Included under this Act are common varieties of sand, gravel, stone, cinders, pumice, pumicite, clay, limestone, dolomite, peat and petrified wood (Maley, 1983).

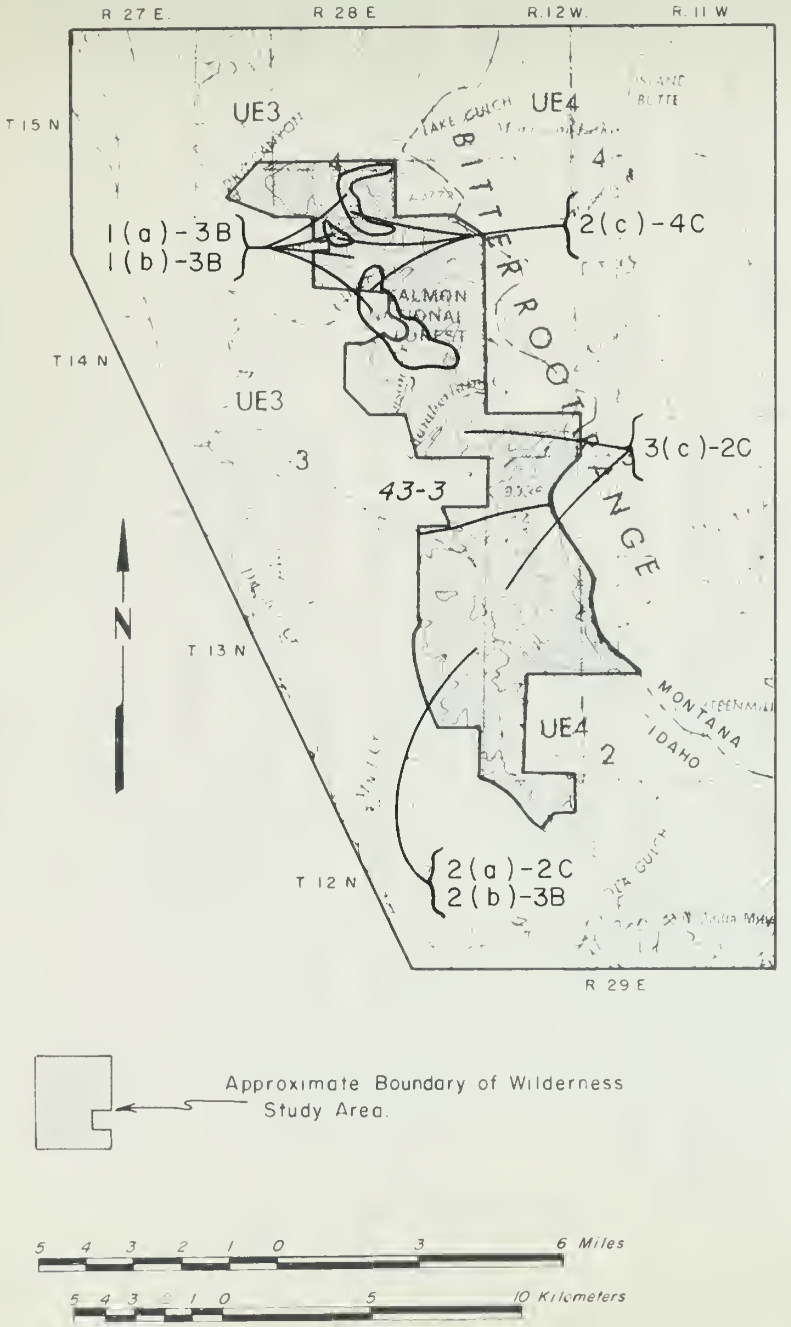
4.2 Classification of the Eighteen Mile Wilderness Study Area (43-3)

4.2.1 Locatable Resources

4.2.1a Metallic Minerals. The portion of the Eighteen Mile Wilderness Study Area which is underlain by Paleozoic sedimentary rocks (1a, Fig. 21) is classified as having moderate potential for silver-lead-zinc deposits, similar to those in the Nicholia district, based on limited direct evidence (3C). The southern part of the WSA (2a, Fig. 21) is classified as having low potential for metallic minerals based on limited direct evidence (2C). The basis for this classification is discussed in Section 3.5.

4.2.1b Uranium and Thorium. The portion of the Eighteen Mile Wilderness Study Area which is underlain by the Beaverhead pluton (2b, Fig. 21) is classified as having moderate potential for thorium and low potential for uranium mineralization based on indirect evidence (3B). The remainder of the WSA (1b, Fig. 21) is classified as having moderate favorability for uranium based on indirect evidence (3B). The basis for this classification is the presence of the McGowan Creek formation in either the surface or subsurface within much of the area.

4.2.1c Non-Metallic Minerals. The portion of the Eighteen Mile Wilderness Study Area which is underlain by rocks of the Big Snowy Formation (2c, Fig. 21) is classified as having high favorability for gypsum based on limited direct evidence (4C). The remainder of the WSA (3c, Fig. 21) is classified as having low potential for non-metallic minerals based on limited direct



BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

LEVELS OF CONFIDENCE

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

EXPLANATION

Area I.D. Number
1(a.)- 4D
Commodity
Classification
Level of Confidence

a) Metallic Minerals
b) Uranium and Thorium
c) Non-Metallic Minerals

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REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA,
Idaho-Montana
Wilderness Study Area
Locatable Resources
Land Classification

SCALE 1" = 4 MILES (1:250,000)			FIGURE
DATA BY WGM	DATE 9/1982	REVISED	2 1
DRWN BY DSI	APRVD G.F.		

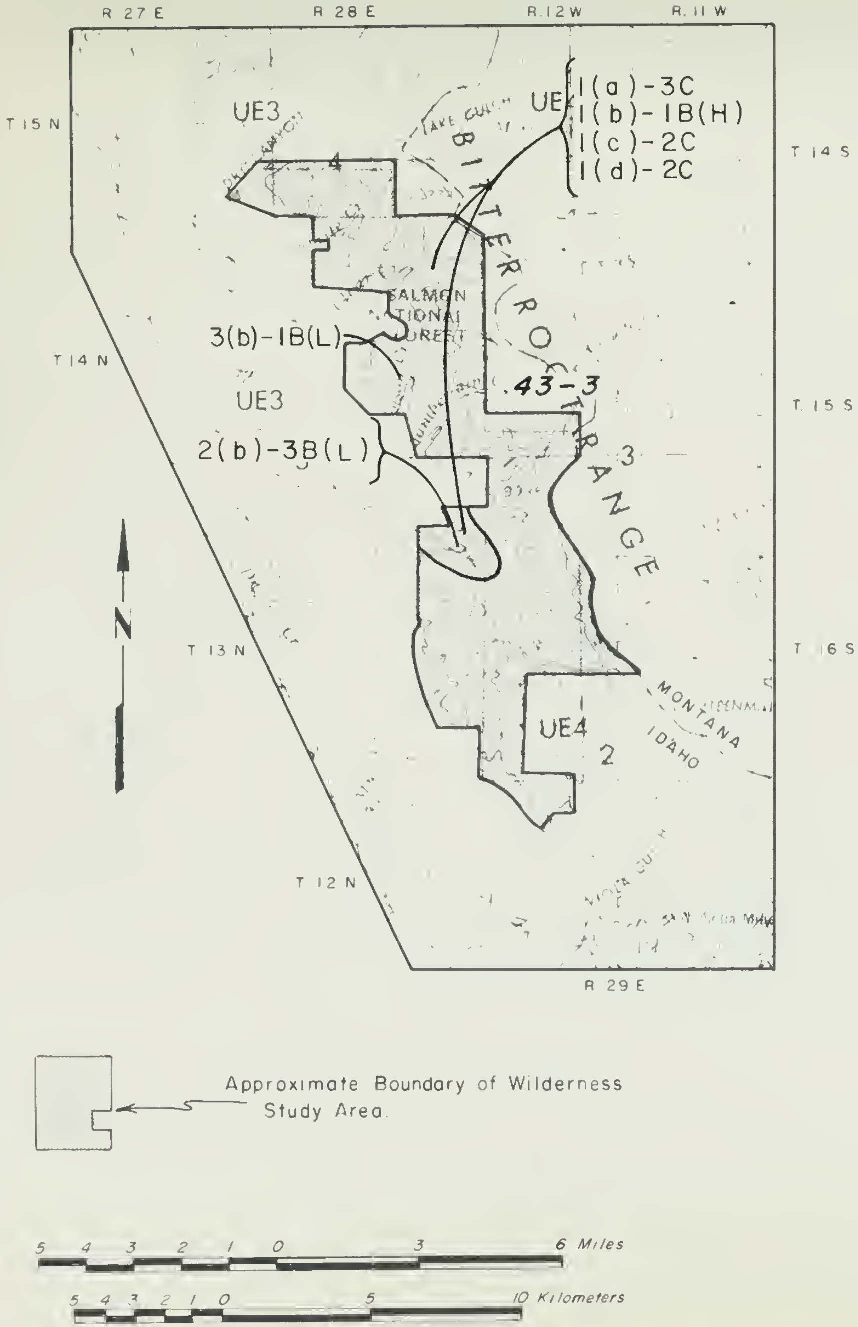
evidence (2C). The basis of this classification is the known gypsum deposit and geologic data discussed in Section 3.5.

4.2.2 Leasable Resources

4.2.2a Oil and Gas. All of the Eighteen Mile Wilderness Study Area (1a, Fig. 22) is classified as having moderate favorability for oil and gas resources based on limited direct evidence (3C). The basis of this classification is the favorable geologic environment coupled with the presence of favorable source rocks and structures.

4.2.2b Geothermal. The portion of Eighteen Mile Wilderness Study Area (2b, Fig. 22) near the mouth of Eighteen Mile Creek is classified has having moderate potential for low temperature geothermal resources based on indirect evidence (3B). The remainder of the WSA (3b, Fig. 22) is classified as being unfavorable for low temperature geothermal resources based on indirect evidence (1B). All of the WSA (1b, Fig. 22) is classified as being unfavorable for high temperature geothermal resources based on indirect evidence (1B). The basis of this classification is the geologic and geothermal setting of the WSA as discussed in Section 3.5.

4.2.2c Sodium and Potassium. The Eighteen Mile Wilderness Study Area (1c, Fig. 22) is classified as having low favorability for sodium and potassium resources based on a limited direct evidence (2C). The basis of this classification is the absence of known occurrences of these minerals in the region and the unfavorable overall geologic environment.



BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

LEVELS OF CONFIDENCE

A THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

EXPLANATION

Area I.D. Number
1(a)- 4D
Commodity
Classification
Level of Confidence

a) oil and gas
b) Geothermal: high temperature (H), Low temperature (L)
c) Sodium and Potassium
d) others: Asphalt (As) bitumen (bt), phosphate (ph), No specific commodity designation indicates that the rating applies to all of the above.

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

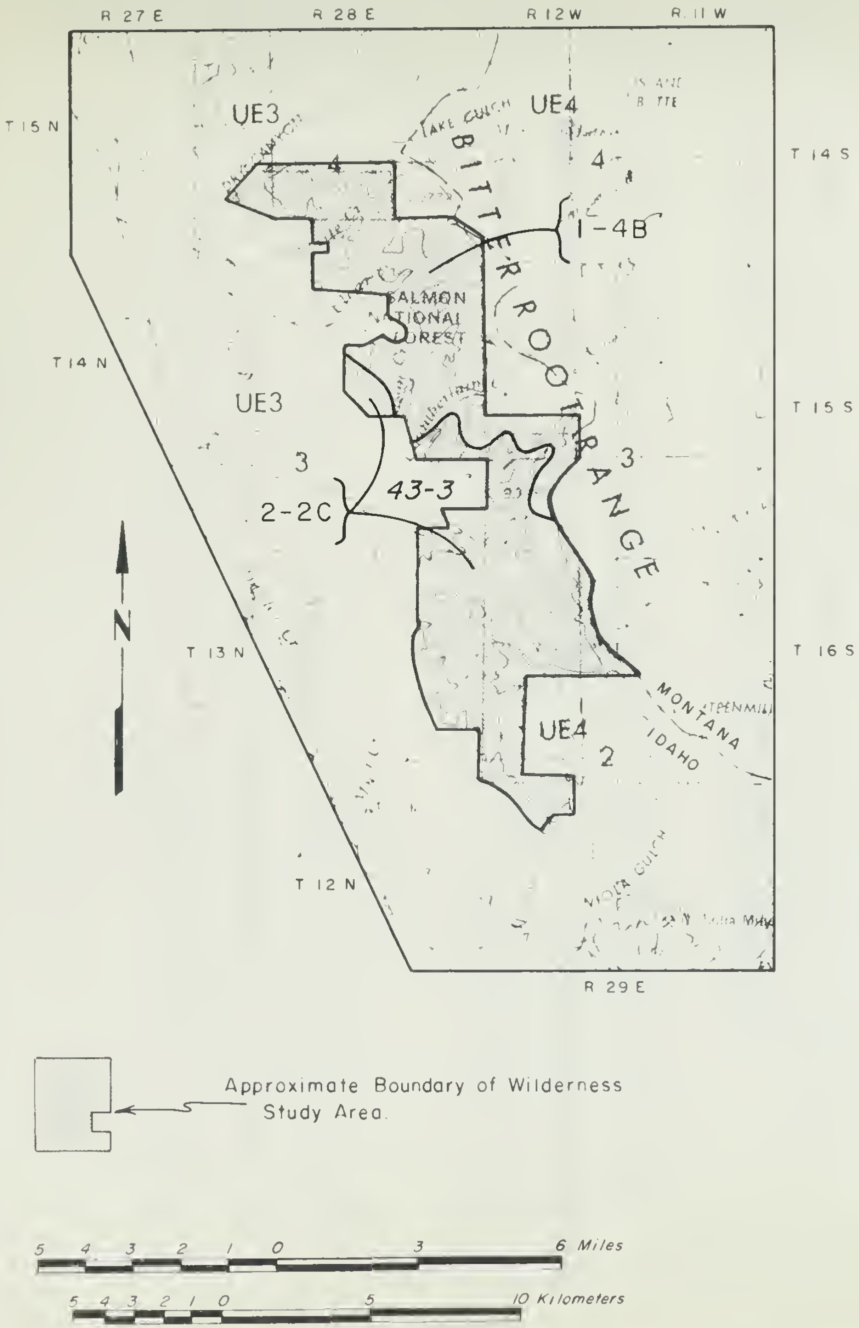
Eighteen Mile GRA,
Idaho-Montana
Wilderness Study Area
Land Classification
Leasable Resources

SCALE 1":4 MILES (1:250,000)
DATA BY WGM DATE 9/1982
DRWN BY DSI APRVD G.F
FIGURE 22

4.2.2d Other. All of the Eighteen Mile Wilderness Study Area (1d, Fig. 22) is classifed as having low favorability for other leasable resources, including phosphate, bitumen, asphalt, and oil shale, based on limited direct evidence (2C). The basis of the classification is the absence of Phosphoria Formation within the WSA and the absence of known occurrences of other leasable resources in the region.

4.2.3 Saleable Resources

The portion of the Eighteen Mile Wilderness Study Area which is underlain by Paleozoic carbonate rocks (1, Fig. 23) is classified as having high favorability for common varieties of limestone and dolomite based on indirect evidence (4B). The remainder of the WSA is classified as having low favorability for saleable resources based on limited direct evidence (2C).



BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

LEVELS OF CONFIDENCE

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

EXPLANATION

1(ls) - 4D

Area I.D. Number
Commodity
Classification
Level of Confidence

s	Sand
g	Gravel
st	Stone
c	Cinders
p	Pumice
pt	Pumicite
cl	Clay
l s	Limestone
dl	Dolomite
P	Peat
pw	Petrified wood

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REGION 2 NORTHERN ROCKY MOUNTAINS

Eighteen Mile GRA, Idaho-Montana
Wilderness Study Area
Land Classification
Saleable Resources

SCALE 1:4 MILES (1:250,000)			FIGURE
DATA BY WGM	DATE 9/1982	REVISED	23
DRWN BY DSI	APRVD GF		

5.0 RECOMMENDATIONS FOR FURTHER WORK

The lack of geochemical data for the Eighteen Mile GRA limits the level of confidence of the metallic mineral resource evaluation. Stream sediment and panned concentrate samples should be collected fromall drainages in the GRA at a density of 2 to 3 per square mile. The silt samples should be analyzed for base and precious metals. The panned concentrates should be analyzed for tin, tungsten and thorium.

Ground radiometric traverses should be made over the Beaverhead pluton and the areas underlain by the McGowan Creek Formation to delineate zones of anomalous radioactivity. The procedures followed should be the same as those outlined by Staatz et al. (1972).

The outcrop areas of the Big Snowy Group should be mapped at a scale of 1:24,000 to locate possible additional gypsum deposits. Particular attention should be paid to zones of faulting and deformation.

Analyses should be made of potential hydrocarbon source beds within the Eighteen Mile GRA. This would indicate the types of hydrocarbons that might be expected to be found within the area. It would also provide a thermal maturity history of the area.

The area classed as 3B for low temperature geothermal resources is only a small part of the whole WSA. A geologic reconnaissance to locate the range-valley structural boundary and its intersection with the lineament

along Eighteenmile Creek coincident with a geochemical analysis of any spring waters should be completed. If warranted, three 500 foot holes to test geothermal gradients should be drilled as follows: (1) near the mouth of Dry Canyon, (2) Eighteenmile Creek Valley in sec. 11, T.14N., R.28E., and (3) along the range front in T.13N., R.28E. These three holes would be sufficient for gradient evaluation.

6.0 REFERENCES AND SELECTED BIBLIOGRAPHY

Anderson, A.L., 1929, Geology and ore deposits of the Lava Creek district, Idaho: Idaho Bureau of Mines and Geology, Pamph. 32, 69 p.

______________, 1939, Geology and ore deposits of the Atlanta district, Elmore County, Idaho: Idaho Bureau of Mines and Geology, Pamph. 49, 71 p.

______________, 1943, Geology of the gold-bearing lodes of the Rocky Bar district, Elmore County, Idaho: Idaho Bureau of Mines and Geology, Pamph. 65, 39 p.

______________, 1947, Geology and ore deposits of Boise basin, Idaho: U.S. Geol. Surv. Bull 944-C, p. 119-139.

______________, 1951, Metallogenic epochs in Idaho: Econ. Geol., Vol. 46, p. 592-607.

______________, 1956, Geology and mineral resources of the Salmon Quadrangle, Lemhi County, Idaho: Idaho Bureau of Mines and Geology, Pamph. 106, 102 p.

______________, 1958, Uranium, thorium, columbium, and rare earth deposits in the Salmon region, Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 115, 81 p.

______________, 1959, Geology and mineral resources of the North Fork quadrangle, Lemhi County, Idaho: Idaho Bureau of Mines and Geology Pamphlet 118, 92 p.

______________, 1960, Geology of thorite-rare earth deposits in the Lemhi Pass region in Newton, J., Lemoine, D., Adams, C.N., Anderson, A.L. and Shively, J.A., Study of Two Idaho Thorite Deposits: Idaho Bur. Mines and Geology Pamph. 122, p. 33-39.

______________, 1961a, Thorium mineralization in the Lemhi Pass area, Lemhi County, Idaho: Econ. Geol., Vol. 56, No. 1, p. 177-197.

______________, 1961b, Geology and mineral resources of the Lemhi Quadrangle, Lemhi County (Idaho): Idaho Bur. Mines and Geology Pamph. 124, 111 p.

Anderson, A.L. and Rasor, A.C., 1934, Silver mineralization in the Banner district, Boise County, Idaho: Econ. Geol., Vol. 29, No. 4, pp. 371-387.

Anderson, A.L. and Wagner, W.R., 1944, Lead-zinc-copper deposits of the Birch Creek district, Clark and Lemhi Counties, Idaho: Idaho Bureau of Mines and Geology, Pamph. 70, 43 p.

Appleyard, F.C., 1975, Gypsum and Anhydrite in Industrial Minerals and Rocks: American Inst. of Mining, Metall. and Petrol. Engs., New York pp. 185-200.

Austin, S.R., Hetland, D.L., and Sharp, B.J., 1970, Mineralogy of the Lemhi Pass thorium and rare-earth deposits: Idaho Bur. Mines and Geology Mineral Resources Rept. 11, 10 p.

Ball, L., Sailsbury, J.W., Kintzinger, D.R., Veneruso, A.F. and Ward, S.H., 1979, The national geothermal exploration technology program: Geophysics, Vol. 44, pp. 1721-1737.

Bennett, E.H., 1980, Granitic rocks of Tertiary age in the Idaho batholith and their relation to mineralization: Econ. Geol., Vol. 75, pp. 278-288.

Bennett, E.H., Miller, M.M., Markland, T.R., Pitman, W.R., Lockard, D.W. and Peterson, J.G., 1982, Developments in minerals, mining and energy in Idaho for 1981: Idaho Bureau of Mines and Geology, Reprint 7, 18 p.

Bergendahl, M.H., 1964, Gold in Mineral and Water Resources of Idaho: Idaho Bureau of Mines and Geology, Spec. Rpt. No. 1, pp. 93-101.

Beutner, E., 1977, Causes and consequences of curvature in the Sevier orogenic belt: Wyoming Geology Society Guidebook, 29th Annual Field Conf., pp. 353-366.

Blake, O.D., 1956, Big Snowy-Amsden stratigraphy in southwestern Montana (abs.): Geol. Soc. of America Bull., Vol. 67, No. 12, p. 1672.

___________, 1959, Big Snowy-Amsden stratigraphy in the area adjacent to the Rocky Mountain front in Sawtooth-Disturbed Belt Area: Billings Geological Society 10th Annual Field Conference, p. 64-68.

Breckenridge, R.M., 1982, Oil and gas exploration in Idaho: Idaho Bureau of Mines and geology, 1 sheet.

Brott, C.A., Blackwell, D.D. and Ziagos, J.P., 1981, Thermal and tectonic implications of heat flow in the eastern Snake River Plain, Idaho, J. Geophys. Res., Vol. 86, p. 11709-11734.

Callahan, W.H., 1967, Some spatial and temporal aspects of the localization of Mississippi Valley-type ore deposits: Econ. Geol. Mon. 3, pp. 14-19.

Christiansen, R.L. and McKee, E.H., 1978, Late Cenozoic volcanic and tectonic evolution of the Great Basin and Columbia Intermontane regions: Geol. Soc. America Mem. 152, p. 283-312.

Claypool, G.E., Love, A.H., and Maughan, E.K., 1978, Organic geochemistry, incipient metamorphism, and oil generation in black shale members of Phosphoria Formation, western interior United States: Am. Assoc. of Petroleum Geologists Bull., Vol. 62, p. 98-120.

Cole, G.A., Berg, R.B., Cromwell, U.A., and Sonderegger, J.L., 1982, Energy resources of Montana: Mont. Bur. Mines and Geol. Geologic Map 28, scale 1:500,000.

Day, N.F., 1974, Linears Map, Band 5, MSS-ERTS, northern and southern Idaho: Idaho Bureau of Mines and Geology Open-File Map, 2 Fig.

Dover, J.H., 1980, Status of the Antler orogeny in central Idaho - Clarifications and constraints from the Pioneer Mountains in Fouch, T.D. and Magethan, E.R., eds., Paleozoic Paleogeography of the West-Central United States: Soc. of Economic Paleontologists and Mineralogists, Rocky Mountain Section, West-Central United States Paleogeography Symposium, 1, p. 371-386.

___________, 1981, Chapter A-Geology of the Boulder-Pioneer study area in Mineral Resources of the Boulder-Pioneer Wilderness Study Area, Blaine and Custer Counties, Idaho: U.S. Geol. Surv. Bull. 1497, p. 16-75.

Dyni, J.R., and Schell, E.M., 1982, Tertiary coals in Medicine Lodge Creek Valley, Beaverhead County, Montana: Mont. Bur. Mines and Geol., Geol. Map 29, 18 p.

Ellis, A.J. and Mahon, W.A.J., 1977, Chemistry and geothermal systems: Academic Press, New York, 329 p.

Garmezy, Lawrence and Scholten, Robert, 1981, Multiple deformation in a portion of the fold and thrust belt; southern Beaverhead Mountains, east-central Idaho: Geol. Soc. America Abstracts with Programs, Vol. 13, No. 4, p. 198.

Geach, R.D., 1966, Thorium deposits of the Lemhi Pass district, Beaverhead County, Montana: Montana Bur. Mines and Geology Spec. Pub. 41, 22 p.

___________, 1972, Mines and Mineral Deposits (except fuels), Beaverhead County Montana: Mont. Bur. Mines and Geol., Bull. 85, 194 p.

Hait, M.H., Jr. and Scott, W.E., 1978, Holocene faulting, Lost River Range, Idaho (abs): Geol. Soc. America Abstracts with Programs, Vol. 10, No. 5, p. 217.

Hall, W.E., Rye, R.O. and Doe, B.R., 1978, Wood River mining district, Idaho-Intrusion related lead-silver deposits derived from country rock source: U.S. Geol. Surv., Jour. Research, Vol. 6, pp. 579-592.

Haskett, G.R., 1976, Thermal springs and wells, lineaments and circular feature map of Idaho: U.S. Bureau of Rec. Map, Open-File.

Heany, M.A., 1961, Blackleaf field in Montana Oil and Gas Field Symp.: Billings Geologicial Society, 1961 Supplement, 3 p.

Heyl, A.V. and Bozion, C.N., 1962, Oxidized zinc deposits of the United States: U.S. Geol. Surv. Bull. 1135.

Hobbs, S.W., 1968, Geological setting of metallic ore deposits in the northern Rocky Mountains and adjacent areas in Ridge, J.D. (ed.), Ore Deposits in the United States 1933/1967: American Inst. of Mining Metall. and Petrol. Engs., New York, pp. 1351-1373.

__________, 1980, The Lawson Creek Formation of middle Proterozoic age in east-central Idaho: U.S. Geol. Surv. Bull. 1482-E, 12 p.

Huh, O.K., 1967, The Mississippian System across the Wasatch line east-central Idaho, extreme southwestern Montana: Montana Geol. Society Guidebook 18th Annual Field Conference, p. 31-62.

Hunt, C.B., 1974, Natural regions of the United States and Canada: W.H. Freeman and Company, p. 409-414.

Johns, W.M., 1980, Gypsum deposits in Beaverhead County, Montana: Mont. Bur. Mines and Geol., Geol. Map 13, 24 p.

Kiilsgaard, T.H., 1964, Silver, lead and zinc in Mineral and Water Resources of Idaho: Idaho Bureau of Mines and Geology, Spec. Rpt. No. 1, pp. 181-194.

King, P.B., 1969, The tectonics of North America - a discussion to accompany the tectonic map of North America, scale 1:5,000,000: U.S. Geol. Surv. Prof. Paper 628, 95 p.

Kirk, W.S., 1981, Thorium: U.S. Bureau of Mines Minerals Yearbook 1981, Vol. 1, pp. 833-838.

Kirkham, V.R.D., 1927, A geologic reconnaissance of Clark and Jefferson and parts of Butte, Custer, Fremont, Lemhi, and Madison Counties, Idaho: Idaho Bur. Mines and Geology Pamph 19, 47 p.

Lamb, C.F., 1980, Painter reservoir field -- giant in Wyoming thrust belt: Am. Assoc. of Petroleum Geologists Bull. Vol. 64, p. 638-644.

Loucks, G.G., 1977, Geologic history of the Devonian, northern Alberta to southwest Arizona: Wyoming Geol. Assoc. Guidebook, 29th Annual Field Conf., pp. 119-134.

Loughlin, G.F., 1918, The oxidized zinc ores of Leadville, Colorado: U.S. Geol. Surv., Bull. 681, 87 p.

Lowell, W.R., and Klepper, M.R., 1953, Beaverhead formation, a Laramide deposit in Beaverhead County, Montana: Geol. Soc. America Bull., Vol. 64, No. 2, p. 235-244.

Lowell, W.R., 1965, Geologic map of the Bannack-Grayling area, Beaverhead County, Montana: U.S. Geol. Surv. Misc. Geol. Inv. Map I-433.

Lucchitta, B.K., 1966, Structure of the Hawley Creek area, Idaho-Montana: Penn. State Univ. Ph.D. Thesis, University Micro Films, Ann Arbor, Mich., 235 p.

Lucke, E.W., 1982, Gypsum, depressed housing market reduces gypsum demand: Eng. and Mining Jour., Vol. 183, No. 3, pp. 122-123.

Maley, T., 1983, Handbook of mineral law: MMRC Publ., Boise, Idaho 293 p.

Mansfield, G.R., 1929, Geography, geology, and mineral resources of the Portneuf Quadrangle, Idaho: U.S. Geol. Surv. Bull. 803, 110 p.

McCaslin, J.C., 1980, Amoco scores deep Nugget hit in overthrust: Oil and Gas Journal, Vol. 78, No. 33, p. 161.

______________, 1981, Six new fields make list of U.S. oil giants: Oil and Gas Journal, Vol. 79, No. 4, p. 153.

McIntyre, D.H., Hobbs, S.W., Marvin, R.F. and Mehnert, H.H., 1976, Late Cretaceous and Eocene ages for hydrothermal alteration and mineralization, Bayhorse district and vicinity, Custer County, Idaho: Isochron/west, No. 16, pp. 11-12.

Meinzer, O.E., 1924, Ground water in Pahsimeroi Valley, Idaho: Idaho Bureau of Mines and Geology Pamph. 9, 35 p.

Meyers, W.B., 1952, Geology and mineral deposits of the northwest quarter of Willis Quadrangle and adjacent Browns Lake area, Beaverhead County, Montana: U.S. Geol. Surv. Open-File Rpts., 46 p.

Mitchell, A.H.G. and Garson, MS., 1981, Mineral deposits and global tectonic settings: Academic Press, London, 405 p.

Mitchell, J.C., Johnson, L.L. and Anderson, J.E., 1980, Geothermal investigations in Idaho: Part 9, Potential for direct heat application of geothermal resources: Idaho Dept. of Water Resources, Water Inf. Bull. No. 30, 396 p.

Mitchell, V.E., Strowd, W.B. Hustedde, G.S. and Bennett, E.H., 1981, Mines and prospects of the Dubois Quadrangle, Idaho: Idaho Bureau of Mines and Geology, Mines and Prospects Map Series, 22 p.

Monley, L.E., 1971, Petroleum potential of Idaho-Wyoming overthrust belt in Future Petroleum Provinces of the United States -- Their Geology and Potential, I.H. Cram (ed.): Am. Assoc. of Petroleum Geologists, Mem. 9, Vol. 1, p. 509-529.

Moritz, C.A., 1951, Triassic an Jurassic stratigraphy of southwestern Montana: Am. Assoc. Petroleum Geologists Bull., Vol. 35, p. 1781-1814.

Muffler, L.J.P. (ed.), 1979, Assessment of geothermal resources of the United States, 1978: U.S. Geol. Surv., Circ. 790, 163.

Nelson, W.H. and Ross, C.P., 1969, Geologic map of the MacKay Quadrangle, south-central Idaho: U.S. Geol. Surv., Misc. Geol. Inv. Map I-580.

Noble, J.A., 1970, Metal provinces in the western United States: Geol. Soc. America Bull., Vol. 81, pp. 1607-1624.

__________, 1974, Metal provinces and metal finding in the western United States: Mineral. Deposit, Vol. 9, p. 1-25.

Oberlindacher, P., and Hovland, R.D., 1979, Geology and phosphate resources of the Hawley Creek area, Lemhi County, Idaho: U.S. Geol. Surv., Open-File Rept. 79-1283, 18 p.

Perry, W.J., Ryder, R.T., and Maughan, E.K., 1981, The southern part of the southwest Montana Thrust belt, a preliminary re-evaluation of structure, thermal maturation and petroleum potential: Montana Geological Society 1981 Field Conference and Symposium Guidebook to Southwest Montana, p. 261-273

Peterson, J.A., 1981, General stratigraphy and regional paleostructure of the western Montana Thrust belt: Montana Geological Society Field Conference and Symposium Guidebook to Southwest Montana, p. 5-35.

Poole, F.G. and Sandberg, C.A., 1977, Mississippian paleogeography and tectonics of the western United States in Stewart, J.H., Stevens, C.H. and Fritsche, A.E., eds., Paleozoic Paleogeography of the Western United States: Soc. Econ. Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symp. 1, p. 67-85.

Pressler, J.W., 1981, Gypsum: U.S. Bureau of Mines Minerals Yearbook 1981, Vol. 1, pp. 405-415.

Ramspott, L.D., 1962, Middle Paleozoic faulting along geosynclinal margin north of Snake River plain: Geol. Soc. America Special Paper 73, p. 221-222.

Ramspott, L.D., and Scholten, Robert, 1964, Early Paleozoic batholith in the Beaverhead Range, Idaho-Montana: Geol. Soc. America Spec. Paper 82, p. 159-160.

Reed, J.C., 1937, Geology and ore deposits of the Warren mining district, Idaho County, Idaho: Idaho Bureau of Mines and Geology Pamph. 45, 65 p.

__________, 1939, Geology and ore deposits of the Florence mining district, Idaho County, Idaho: Idaho Bureau of Mines and Geology Pamph. 46, 44 p.

Rember, W.C. and Bennett, E.H., 1979, Geologic map of the Dubois Quadrangle, Idaho: Idaho Bureau of Mines and Geology, Geologic Map Series, 1:250,000 scale.

Rooney, L.F., 1956, Organic carbon in Phosphoria Fomation: Am. Assoc. of Petroleum Geologists Bull., Vol. 40, p. 2267-2271.

Rose, P.R., 1976, Mississippian carbonate shelf margins, western United States: U.S. Geol. Surv. Journal of Research, Vol. 4, No. 4, p. 449-466.

Ross, C.P., 1930, Geology and ore deposits of the Seafoam, Alder Creek, Little Smoky and Willow Creek mining districts, Custer and Camas Counties, Idaho: Idaho Bureau of Mines and Geology Pamph. 33, 26 p.

__________, 1931, A classification of lode deposits of south-central Idaho: Econ. Geol., Vol. 26, p. 169-185.

__________, 1937, Geology and ore deposits of the Bayhorse region, Custer County, Idaho: U.S. Geol. Surv. Bull. 877, 161 p.

__________, 1947, Geology of the Borah Peak Quadrangle, Idaho: Geol. Soc. America Bull., Vol. 58, No. 12, p. 1085-1160.

__________, 1961, Geology of the southern part of the Lemhi Range, Idaho: U.S. Geol. Surv. Bull., 1081-F, p. 189-260.

__________, 1962, Paleozoic seas of central Idaho: Geol. Soc. America Bull., Vol. 73, p. 769-794.

Ross, S.H., 1971, Geothermal potential of Idaho: Idaho Bureau of Mines and Geology, Pamph. 150, 72 p.

Rosta, J., 1982, Silver in 1981-1982, 113th Annual Survey of Mineral Commodities: Engineering and Mining Jour., March 1982, p. 143-145.

Ruppel, E.T., 1964, Strike-slip faulting and broken basin-ranges in east-central Idaho and adjacent Montana: U.S. Geol. Surv. Prof. Paper 501-C, p. C14-C18.

____________, 1968, Geologic map of the Leadore Quadrangle, Lemhi County, Idaho: U.S. Geol. Surv. Geol. Quad. Map GQ-733.

____________, 1975, Precambrian Y sedimentary rocks in east-central Idaho, Chap. A. of Precambrian and Lower Ordovician rockd in east-central Idaho: U.S. Geol. Surv. Prof. Paper 889, p. 1-23.

____________, 1976, Medicine Lodge thrust system, east-central Idaho and southwest Montana: U.S. Geol. Surv. Open-File Rpt. 76-366, 25 p.

____________, 1978, Medicine Lodge Thrust system, east-central Idaho and southwest Montana: U.S. Geol. Surv. Prof. Paper 1031, 23 p.

Ruppel, E.T., 1982, Cenozoic block uplifts in east-central Idaho and southwest Montana: U.S. Geol. Surv. Prof. Paper 1224, 24 p.

Ruppel, E.T. and Lopez, D.A., 1981, Geologic map of the Gilmore Quadrangle, Lemhi County, Idaho: U.S. Geol. Surv., Geol. Quad. Map GQ-1543.

Ruppel, E.T., Ruben, J.R., Jr. and Schleicher, D., 1975, Precambrian Z and Lower Ordovician rocks in east-central Idaho in Precambrian and Lower Ordovician Rocks in East-central Idaho: U.S. Geol. Surv. Prof. Paper 889, p. 24-34.

Ruppel, E.T., Wallace, C.A., Schmidt, R.G. and Lopez, D.A., 1981, Preliminary interpretation of the Thrust belt in southwest and west-central Montana and east-central Idaho: Montana Geological Society Field Conf., p. 139-159.

Ruppel, E.T., Watts, K.C. and Peterson, D.L., 1970, Geologic, geochemical and geophysical investigations in the northern part of the Gilmore mining district, Lemhi County, Idaho: U.S. Geol. Surv., Open-File Rpt., 56 p.

Sandberg, C.A., 1975, McGowan Creek Formation, new name for Lower Mississippian flysch sequence in east-central Idaho: U.S. Geol. Surv. Bull., 1405-E, 11 p.

Sangster, D.F., 1976, Carbonate-hosted lead-zinc deposits in Wolf, K.H. (ed.), Handbook of Stratabound and Stratiform Ore Deposits, Vol. 6, pp. 445-456, Elsevier, Amsterdam.

Savage, C.N., 1969, Distribution and economic potential of Idaho carbonate rocks: Idaho Bureau of Mines and Geology Bull. 23, 99 p.

Scholten, R., 1957, Paleozoic evolution of the geosynclinal margin north of the Snake River Plain, Idaho-Montana: Geol. Soc. of America Bull., Vol. 68, p. 151-170.

____________, 1967, Structural framework and oil potential of extreme south-western Montana: Montana Geological Society Guidebook 18th Annual Field Conference, p. 7-20.

____________, 1968, Model for evolution of Rocky Mountains east of Idaho batholith: Tectonophysics, Vol. 16, No. 2, p. 109-126.

____________, 1973, Gravitational mechanisms in the northern Rocky Mountains of the United States in DeJong, K.A., and Scholten, R., eds., Gravity and Tectonics: John Wiley and Sons, Inc., New York p. 473-489.

Scholten, R. and Hait, M.H., Jr., 1962, Devonian System from shelf edge to geosyncline, southwestern Montana-central Idaho in Three Forks-Belt Mountain Area, and Symp., The Devonian system of Montana and Adjacent Areas, Billings Geol. Soc., p. 13-22.

Scholten, R., Keenmon, K.A., and Kupsch, W.O., 1955, Geology of the Lima region, southwestern Montana, and adjacent Idaho: Geol. Soc. of America Bull., Vol. 66, p. 345-404.

Scholten, R. and Ramspott, L.D., 1968, Tectonic mechanisms indicated by structural framework of central Beaverhead Range, Idaho and Montana: Geol. Soc. America Spec. Paper 104, 71 p.

Sharp, W.N., and Cavender, W.S., 1962, Geology and thorium-bearing deposits of the Lemhi Pass area, Lemhi County, Idaho, and Beaverhead County, Montana: U.S. Geol. Surv. Bull. 1126, 76 p.

Sharp, B.J., and Hetland, D.L., 1968, Thorium and rare-earth resources of the Lemhi Pass area, Idaho and Montana: U.S. Atomic Energy Comm. Tech. Memo. AEC-RID-3, 13 p.

Shenon, P.J., 1928, Geology and ore deposits of the Birch Creek district, Idaho: Idaho Bur. Mines and Geology Pamph. 27, 25 p.

Singer, D.A. and Mosier, D.L., 1981, A review of regional mineral resource assessment methods: Econ. Geol., Vol. 76, p. 1006-1015.

Skipp, B., 1981, A synopsis of the structure and stratigraphy of south-central Idaho -- Contributions by the U.S. Geol. Survey since 1975: Montana Geol. Society Field Conf. Southwest Montana, p. 365-372.

Skipp, B. and Hait, M.H., Jr., 1977, Allochthons along the northeast margin of the Snake River Plain, Idaho: Wyoming Geol. Assoc. Guidebook 29th Annual Field Conf., p. 499-515.

Skipp, B. and Hall, W.E., 1980, Upper Paleozoic paleotectonics and paleogeography of Idaho in Fouch, T.D. and Magathan, E.R., eds., Paleozoic Paleogeography of the West-Central United States: Soc. of Economic Paleontologists and Mineralogists, Rocky Mountain Section, West-Central United states Paleogeography Symposium 1, p. 387-422.

Skipp, B., Hoggan, E.D., Schleicher, D.L. and Douglass, R.C., 1979, Upper Paleozoic carbonate bank in east-central Idaho - Snaky Canyon, Bluebird Mountain, and Arco Hills Formations and their paleotectonic significance: U.S. Geol. Surv. Bull. 1486, 78 p.

Skipp, B., Sando, W.J., and Hall, W.E., 1979, Mississippian and Pennsylvanian (Carboniferous) Systems in the United States - Idaho: U.S. Geol. Surv. Prof. Paper 1110, p. AA1-AA43.

Sloss, L.L., and Moritz, C.A., 1951, Paleozoic stratigraphy of southwestern Montana: Am. Assoc. Petroleum Geologists Bull., Vol. 35, No. 10, p. 2135-2169.

Smith, J.G., 1961, The geology of the Clear Creek area, Montana-Idaho: Pennsylvanian State Univ. M.S. thesis.

Smith, R.B., 1978, Seismicity, crustal structural and interplate tectonics of the interior of the western U.S. in Cenozoic Tectonics and Regional Geophysics of the Western Cordillera, R.B. Smith (ed.): Geol. Soc. America, Mem. 152, pp. 111-144.

Sonderegger, J.L. and Bergantino, R.N., 1981, Geothermal resources of Montana: Montana Bureau of Mines and Geology Hydrogeologic Map HM-4.

Staatz, M.H., 1972, Geology and description of the thorium-bearing veins, Lemhi Pass Quadrangle, Idaho and Montana: U.S. Geol. Surv. Bull. 1351, 94 p.

__________, 1973, Geologic map of the Goat Mountain Quadrangle, Lemhi County, Idaho, and Beaverhead County, Montana: U.S. Geol. Surv. Geol. Quad. Map GQ-1097 (1974).

__________, 1974, Thorium veins in the United States: Econ. Geol., Vol. 69, No. 4, p. 494-507.

__________, 1979, Geology and mineral resources of the Lemhi Pass thorium district: U.S. Geol. Surv. Prof. Paper 1049-A, 90 p.

Staatz, M.H., Bunker, C.M., and Bush, C.A., 1971, Geochemical prospecting for thorium veins by stream-sediment sampling, Lemhi Pass quadrangle, Idaho and Montana: U.S. Geol. Surv. Prof. Paper 750-C, p. C136-C140.

______________________________, 1972, Thorium distribution in a granite stock near Bull Canyon, Lemhi County, Idaho: U.S. Geol. Surv., Prof. Paper 800-B, pp. B51-B56.

Staatz, M.H., Shaw, V.E., and Wahlberg, J.S., 1972, Occurrence and distribution of rare earths in the Lemhi Pass thorium veins, Idaho and Montana: Econ. Geol., Vol. 67, No. 1, p. 72-82.

Swanberg, C.A. and Blackwell, D.D., 1973, Areal distribution and geophysical significance of heat generation in the Idaho batholith and adjacent intrusions in eastern Oregon and western Montana: Geol. Soc. America Bull., Vol. 84, p. 1261-1282.

Trites, A.F., Jr., and Tooker, E.W. 1953, Uranium and thorium deposits in east-central Idaho and southwestern Montana: U.S. Geol. Surv. Bull. 988-H, p. 157-209.

Umpleby, J.B., 1913, Geology and ore deposits of Lemhi County, Idaho: U.S. Geol. Surv. Bull. 528, 182 p.

__________, 1917, Geology and ore deposits of the Mackay region, Idaho: U.S. Geol. Surv. Prof. Paper 97, 129 p.

Withington, C.F., 1964, Gypsum and Anhydrite in Mineral and Water Resources of Idaho: Idaho Bureau of Mines and Geology, Spec. Pub. No. 1, p. 233-239.

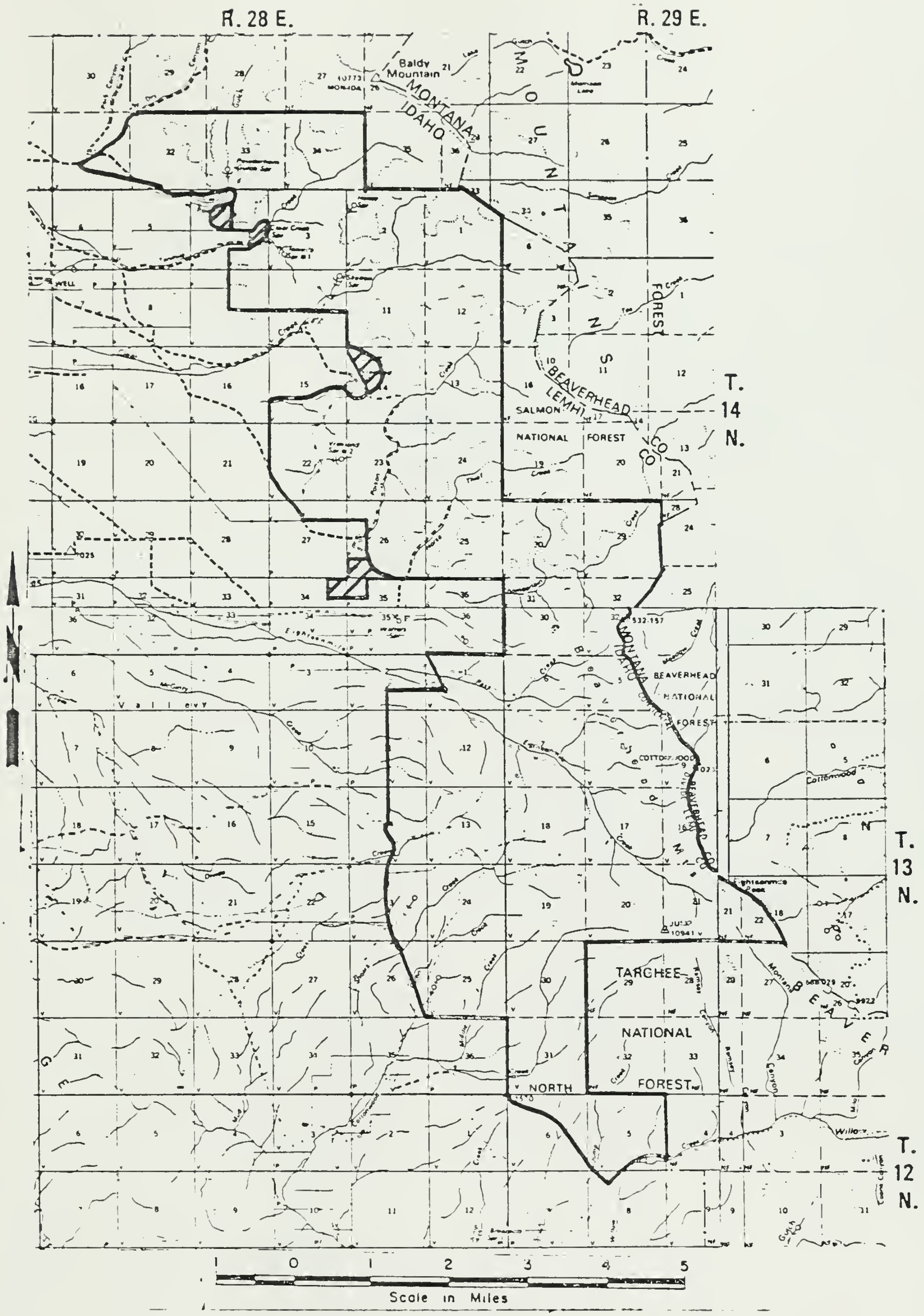
Wodzicki, A. and Krason, J., 1981, National Uranium Resource Evaluation, Dubois Quadrangle, Idaho and Montana: U.S. Dept. of Energy, Rept. GJQ-008(81), 67 p.

APPENDIX I

Wilderness Study Area Map

43–3 90

EIGHTEEN MILE



LEGEND

○ WILDERNESS STUDY AREA

▨ AREA WITHOUT CHARACTERISTICS

APPENDIX II

Field Report

DATE: June 23, 1983

FROM: Greg Fernette, Bill Jones

TO: Eighteenmile GRA File November 25, 1982

SUBJECT: Field Visit to Eighteen Mile GRA

On October 8 and 9, 1982 we visited the EighteenMile Wilderness Study area as part of Task 4 (field verification) of the GEM-2 project.

The field work had two objectives: 1) examine and determine the character of the gypsum deposit on Clear Creek, 2) visit the Nicholia As-P6-Zn district and examine the southern contact of the Beaverhead pluton along Willow Creek.

On October 8 we examined the Clear Creek gypsum mine. We mapped the deposit and attempted to prospect along strike to the south and down plunge to the north. The work was hampered by a snow storm in the afternoon. Our mapping clearly shows that the deposit is stratabound in the shale member of the Big Snowy Group. This is contrary to published descriptions which suggested that the gypsum was a spring deposit. The gypsum is thickened and recrystallized along the crest of a southeast plunging anticline. Therefore, both structure and stratigraphy are to some extent controlling factors.

We visited the Nicholia As-P6-Zn district on the morning of Oct. 9. The adits, and prospect pits on the north side of Viola Gulch are along an ENE trending fault or fracture zone. The largest deposit; the viola, is a series of ENE trending pods of lead-zinc carbonates. Our brief examination confirmed the impression of Anderson and Wagner (1944) and Ruppel (1978) that the mineralization is not obviously related to the Beaverhead pluton.

We then examined the south contact of the Beaverhead pluton along Willow Creek. The country rock is white Kinnikinic quartzite. The granite of the pluton is medium to coarse grained and quite fresh. This is some what at odds with Ramspotts description of extensive hydrothermal alteration. The contact itself is not exposed, however, there is some brecciated granit talus north of the creek. This suggests the possibility of post intrusion faulting. We found no evidence of base metol mineralization associated with the pluton.

Form 1279—3
(June 1984)

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